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Benchmarking sustainability in cities: The role of indicators and future scenarios

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A B S T R A C T

Scenarios are a useful tool to help think about and visualise the future and, as such, are utilised by many policymakers and practitioners. Future scenarios have not been used to explore the urban context in much depth, yet have the potential to provide valuable insights into the robustness of decisions being made today in the name of sustainability. As part of a major research project entitled *Urban Futures*, a toolkit has been developed in the UK to facilitate the use of scenarios in any urban context and at any scale relevant to that context. The toolkit comprises two key components, namely, (i) a series of indicators comprising both generic and topic area-specific indicators (e.g., air quality, biodiversity, density, water) that measure sustainability performance and (ii) a list of characteristics (i.e., 1–2-sentence statements about a feature, issue or small set of issues) that describe four future scenarios. In combination, these two components enable us to measure the performance of any given sustainability indicator, and establish the relative sensitivity or vulnerability of that indicator to the different future scenarios. An important aspect of the methodology underpinning the toolkit is that it is flexible enough to incorporate new scenarios, characteristics and indicators, thereby allowing the long-term performance of our urban environments to be considered in the broadest possible sense.
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1. Introduction

Urban regeneration may be defined as a comprehensive and integrated action that attempts to address urban problems via economic, social, environmental and physical improvements in an area (Roberts and Sykes, 2000). In particular, improving the physical environment is a large-scale process that, at least in the UK, has involved the state to some degree (e.g., the introduction of Single Regeneration Budgets and Urban Regeneration Companies) (Jones and Evans, 2008). American cities, such as Chicago (via Millennium Park) and San Diego (via Downtown San Diego), have tried to regenerate their urban centres by strategic investments and sensitive planning (see Southworth and Ruggeri, 2011). Malmö, Sweden, has become an exemplar city with regard to sustainable development because of key regeneration projects (e.g., the BO01 housing development) that have transformed the area's post-industrial legacy (see Qviström and Saltzman, 2006; Kärrholm, 2011). Seoul, South Korea, used nature to revitalise an urban area by uncovering an important stream, *Cheonggyecheon*, that runs through the city, utilising the stream as a focus for urban redevelopment (see Shin and Lee, 2006; Kang and Cervero, 2009). The Docklands in Melbourne, Australia, have taken advantage of disused space near the city's waterfront and regenerated the area through heritage conservation, public art, business creation and tourism in a bid to expand the Central Business District (Dovey and Sandercock, 2002; Wood, 2009). Finally, Temple Bar in Dublin,

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Ireland, has used culture to lead regeneration in the city (Bryson, 2007), as have Barcelona (1992 Summer Olympics, UNESCO Cultural Forum 2004), Seville (EXPO 1992) and Bilbao (Guggenheim Museum), all in Spain (Evans, 2005).

Although urban regeneration is seen as providing a stimulus to ailing cities, regions and countries, it is a big and costly endeavour for governments who often bear the brunt of fiscal responsibility. For example, the UK government planned to spend over £13 billion in regeneration programmes between 2007 and 2011 (DCLG, 2009). A further £1.5 billion was being set aside for a Working Neighbourhoods Fund to support people living in the most deprived areas in finding work, while a further £80 million was earmarked for transforming hostels and homelessness services into centres of excellence. Prior to this, £1.87 billion was spent over a 5-year period to assist England's 88 most deprived areas via the Neighbourhood Renewal Fund. The previous UK government stated that, by spending this money, they could help reduce the £5.8 billion used annually to subsidise residents in deprived areas and help to directly transform their lives (DCLG, 2009).

To guarantee value for its regeneration money, the previous UK government also had established policies, plans and planning requirements that prioritised the reversal of economic, social and physical decline in deprived areas. Policies and plans, such as Sustainable Development: The UK Strategy (DoE, 1994), Planning Policy Statement 1 (ODPM, 2005a), the Sustainable Communities initiative (ODPM, 2005b) and Securing the Future (ODPM, 2006), and planning requirements, including Section 106 agreements and the soon-to-be-established Community Infrastructure Levy, helped lay the "foundations for flourishing, empowered communities, contributing to the Government's objectives for sustainable development" (DCLG, 2009, p. 11). In creating these foundations for sustainable development, the built environment takes centre stage.

The buildings, spaces and supporting physical infrastructures produced by today's urban regeneration projects may have very long asset lives, lasting hundreds of years in some cases. For example, the water and wastewater infrastructure in some of the UK's major cities still relies on assets that were constructed in the 19th century. Such assets have continued largely to be effective in spite of changes to the context within which they operate that could not have been foreseen at the time of their initial design (Bradford et al., 2010; Halliday, 2001). In contrast, although the social or worker housing built in the UK and the USA in the post-war period was designed to address many of the perceived shortcomings of the housing it replaced, much has been either demolished or substantially redeveloped before the end of its design life (Bullock, 2002; Wolfe, 1981).

Examples such as these highlight the potential for significant, unintended outcomes for assets within the urban environment. Designing and developing the built environment now in what we believe to be a sustainable way, even when evidently avoiding past mistakes, does not guarantee the long-term resilience of that environment (i.e., that it will continue to meet the needs of society for the duration of its lifespan). Changing attitudes, policy emphases and technologies, amongst other things, may mean that what decision-makers implement today for the sake of a sustainable regeneration project will not necessarily contribute to the development of a sustainable future. Investments in sustainable urban regeneration need to be informed by an appreciation of different technologies, but also of behavioural change linked to global environmental change, demographic change—including, in developed countries, an ageing population—and economic restructuring. Because the urban environment, and in particular, regeneration in that environment (Catney and Lerner, 2009), involves the management of many different forms of expertise from decision-makers with very different disciplinary and professional backgrounds, this becomes a difficult task (Evans and Marvin, 2006; Petts et al., 2008). Finding a way to harness insights about plausible futures offers decision-makers involved in planning, design, ecology, engineering, transport, education, health and so forth a method for working together to assess the sustainability of today's solutions (i.e., decisions, methods, tools, techniques, instruments, designs, policies, guidance etc. implemented today in the name of sustainability).

Future scenarios are "plausible, challenging and relevant stories about how the future might unfold, which can be told in both words and numbers" (Raskin et al., 2005, p. 36). These stories provide insight into the present through an identification of drivers of change, the potential outcomes of current trajectories and opportunities for engagement and exploitation (Raskin et al., 1998). That is, scenario-building is not aimed at predicting the future, but at better understanding uncertainties so that decisions are robust under a wide range of possible futures (Schwartz, 1996; Moss et al., 2010). Future scenarios have been applied to the global (e.g., Nakicenovic and Swart, 2000; Moss et al., 2010), European (e.g., Rotmans et al., 2000), national (e.g., DTI, 2002) and city-region (Ravetz, 2000) scales. However, if what is learned from future scenarios is going to be applicable to the context of today's regeneration projects and impact on public and private sector decisions (Berkhout and van Drunen, 2007), then strategies are required that tailor large-scale futures-thinking to local contexts (Hunt et al., 2008).

Through the description of a broad strategy to use futures thinking in sustainable urban regeneration—in this case, the strategy is a toolkit, developed by the Urban Futures (UF) project[1]—this paper aims to answer the following research question: *How can the impact of uncertain futures on the performance of different indicators for sustainability in an urban regeneration context be systematically quantified and qualified?* The UF toolkit has two key components: (1) a series of generic and topic area-specific indicators that reflect current best practice for measuring sustainability performance; and (2) a list of characteristics that describe four different futures, derived from the existing scenarios literature. For the purposes of this paper, an *indicator* is a variable that represents an attribute of a system. It may be used to assess conditions and trends, compare across places and situations, provide early warning information and anticipate future conditions and trends (Gallopin, 1997; see also Hunt et al., 2008; Tunstall, 1992, 1994). A *characteristic* is a 1–2-sentence statement about an issue or small set of issues, used to describe scenarios. The toolkit, which represents a broad strategy, method or process for decision-makers and stakeholders to better understand their decisions made today, assesses the performance of individual indicators in different future scenarios and can be applied globally and at different scales. Finally, it allows a range of different, plausible futures to be explored systematically. The paper concludes with a discussion of how to adapt the toolkit to new scenarios (and to new characteristics for existing scenarios) and new indicators.

2. Assessing performance in the urban environment

2.1. Using indicators to assess performance

A range of discipline-specific activities is required to assess the performance of sustainable urban environments, such as understanding commercial rental rates and business cycles (economics);

[1] Urban Futures is a 4-year, UK Research Council (EPSRC)-funded project that seeks to establish and test alternative future scenarios, providing insights into the potential sustainability impact of today's UK urban regeneration decisions (see www.urban-futures.org for more information).

measuring particulate matter to identify air pollution (chemistry) and; designing, monitoring and managing sub-surface infrastructure (engineering). These activities can be translated into topic area-specific indicators that highlight progress in crucial areas for sustainable development that may assist in identifying how, when and where action may be required (DEFRA, 2009; see also Hammond et al., 1995; Pagina, 2000). Such indicators also can help to identify past trends; evaluate policy actions (Rydin et al., 2003; van der Heijden, 1997); guide and mould policy decisions (Hezri and Dovers, 2006; Rydin et al., 2003); add to the process of governance (Rydin et al., 2003); communicate with local communities about activities undertaken by organisations that are using indicators (Gahin et al., 2003; Rydin et al., 2003); better understand views on sustainable development (Hezri and Dovers, 2006; Rydin et al., 2003); influence people and their behaviour (Sommer, 2000; Vedung and van der Doelen, 1998); and create a practical and reasonable evidence base to improve policymakers' decisions at a variety of scales relating to sustainability (Alberti, 1996; Pannell and Schilizzi, 1999; Pannell and Glenn, 2000).

Indicator measures may be either quantitative (e.g., distance in metres to the nearest school, general practitioner or transport link to assess accessibility) or qualitative (e.g., subjective perception of crowding to assess cultural values associated with density). They may be associated with benchmarks (e.g., specific standards state that people living in towns and cities should have an accessible natural greenspace of at least 2 ha in size, no more than 300 m, 5 min walk, from home; Natural England, 2008), best practice guidance (e.g., Urban Design Compendium, Llewelyn-Davies, 2000), typical guidance and even 'sustainability ranges', which are minimum and maximum threshold values for sustainability indicators (Wiek and Binder, 2005). The Audit Commission (2000, 2009), Audit Commission and IDeA (2002) and the DETR (1999) in the UK provide examples of these approaches.

Although indicators are being used increasingly to assess performance of sustainability and urban regeneration, some issues arise that call into question their universal acceptance. Some scholars are sceptical that a clear relationship exists between indicator development and real change in decision-making and policy (see Gahin et al., 2003; Innes and Booher, 1999; Maclaren, 1996; Rydin et al., 2003). This could be due to a paucity of strong, evaluative research and monitoring on indicators (Imrie and Thomas, 1995), as well as an over-emphasis on quantitative assessment at the expense of qualitative measurement (Turok, 1989; Burns, 2000; Hakim, 2000; Wong, 2002). Moreover, there has been little investigation of benchmarking 'good sustainability practice' in urban regeneration due to the relative infancy of sustainable urban regeneration (Hemphill et al., 2004b). To combat these issues, UF has used a mixture of qualitative and quantitative indicators that reflect the multidisciplinary issues being researched on the project. Indicators also have been appropriated from a variety of 'good sustainability practice' sources, including governmental (e.g., DCLG, DoE) and non-governmental organisations (e.g., CABE) as well as the private sector (e.g., Water UK).

2.2. Using indicators in the toolkit

The first stage of the UF toolkit was for each topic area represented in the project to ask key, topic area-specific questions that would help identify indicators.[2] For example, those involved in *Water and Waste Water* asked, "*How clean is the drinking water*?", which led to water researchers on the UF team identifying a *Water Quality indicator*. Through its eight topic areas, the UF project has tried to represent a diversity of issues that are found within the urban environment, examining them from below ground (e.g., sub-surface infrastructure, tree roots), at ground level (e.g., buildings and open spaces, urban density, attitudes of citizens about their local government) and from above (e.g., air pollution, bird and bat corridors). Moreover, where possible and where expertise allowed, additional indicators have been incorporated that speak to issues not directly related to the topic areas, yet are inherently important to sustainable urban regeneration (e.g., transportation, health).

Once indicators and key questions were asked, metrics for each indicator were selected—for *Water Quality*, one metric was: *Percentage compliance of drinking water standards*. The final part of this first stage entailed finding an appropriate *benchmark* for each indicator, which compares indicator performance against a clearly defined, fixed and accepted norm (Audit Commission, 2000), as seen in Table 1. For UF, benchmarks could be current guidelines (i.e., what is required), current best practice (i.e., what is achievable), current typical practice or behaviour (i.e., what is currently done), or the current situation (i.e., what is happening now as a result of what has happened in the past; an average). With *Water Quality*, the benchmark was 100% potable water, which is considered best practice, as defined by Water UK (2009). Table 1 also shows whether each sample indicator is quantitative or qualitative, at what scale the indicator is used and to what research area the indicator belongs.

For many disciplines, professions and research areas involved in the process of urban regeneration, comprehensive lists of indicators and benchmarks for what can be considered 'best practice' performance already exist (see Hemphill et al., 2004b, for an evaluation of six urban regeneration schemes in Europe). For example, at a building scale, tools such as *The Code for Sustainable Homes* in the UK, *Leadership in Energy and Environmental Design* in the US, *Green Star* in Australia and the *Comprehensive Assessment System for Built Environment Efficiency* in Japan provide detailed guidance on the performance of issues such as energy and water consumption (DCLG, 2008; Green Building Council of Australia, 2010; Japan Sustainable Building Consortium, 2010; U.S. Green Building Council, 2010). Similarly, at an urban scale, the *Urban Design Compendium* in the UK offers guidance on issues such as the mix of densities for a range of housing types, locations and levels of car parking provision (Llewelyn-Davies, 2000). As such, the list of indicators and associated information is based on existing knowledge and expertise.

The end result of this first stage in the development of the UF toolkit was a matrix of more than 120 indicators and associated benchmarks, spread across the eight topic areas represented in the project. Working across different topic areas in this respect underscores the potential differences in scale between indicators and the changing nature of the types of data required to quantify or qualify performance. For example, decision-makers wishing to consider percentage tree cover as a quantitative indicator of one aspect of a sustainable urban regeneration site relating to wildlife connectivity would need to look at a larger scale, beyond just the site, to fully understand the sustainability benefits of those trees. Although the indicators are focussed on different scales and take different forms (i.e., qualitative, quantitative), the information gleaned from their performance can be used by decision-makers to make more informed and holistic decisions about the sustainability of urban regeneration sites and areas. Furthermore, working across different topic areas, as has been done in the UF toolkit, helps identify potential areas of overlap between aspects of sustainability. For example, dwelling density, as measured by the number of dwellings per hectare, may be used as one indicator of

[2] Topic areas represented in the UF project include: biodiversity; air quality; water and waste water; sub-surface built environment, infrastructure and utility services; surface built environment and open spaces; density and design decision-making; organisational behaviour and innovation; and social needs, aspirations and planning policy.

Table 1
Sample of *Urban Futures* indicators.

Indicator	Question	Metric	Benchmarks	Qualitative/ quantitative	Scale[a]	Research area
Conservation volunteering	Are there high levels of public support for wildlife conservation?	Percentage of the population engaged in conservation volunteering	51% (JNCC, 2009)	Quantitative	Country	Biodiversity
NO_2 1-h average	Does urban air quality pose a significant risk to human health	Ambient concentration averaged over 1 h	200 $\mu g\, m^{-3}$ (DEFRA, 2007)	Quantitative	Point	Air quality
Water quality	How clean is the drinking water?	Percentage compliance with drinking water standards	100% (Water UK, 2009)	Quantitative	Region	Water and waste water
Asset condition	How much water is being lost through leakage within the supply network?	Water supplied minus water delivered (given as % water supplied)	16.6% (EA, 2009)	Quantitative	Region	Sub-surface built environment, infrastructure and utility services
Quality of the public realm	Are streets being defined by a well-structured building layout?	Active frontage type	More Grade A, B and C frontage types, less Grade D and E (Llewelyn-Davies, 2000)	Qualitative	Neighbourhood	Surface built environment and open spaces
Dwelling density	What is the average density of new housing in an area?	Dwellings per hectare (dph)	30 dph (DCLG, 2007b)	Quantitative	Development	Density and decision-making
Innovation	How innovative is the construction sector?	Percentage of business expenditure spent on innovation in managerial techniques and organisation	29.2% (Roper et al., 2009)	Quantitative	Development	Organisational behaviour & innovation
Participation in local issues	Do people feel they can influence decisions relating to their local area?	Percentage of people who feel civically engaged; percentage of people who have taken some action to solve a local problem in the last 3 years	18%; 27% (ONS, 2002)	Quantitative	Neighbourhood	Social needs, aspirations and planning policy

[a] The scale of the indicators varies along the following spectrum: point, building, development, neighbourhood, city, region, country, international.

the compactness of an area. However, this indicator also may be helpful to decision-makers specialising in the built environment, as the density of dwellings in an area may inform the size or massing of buildings and the settlement pattern. Knowing how many dwellings exist in an area further may inform the kinds of services or infrastructure needed in an area, both above ground and under ground, as well as the number and types of trees that can be planted. Identifying overlapping indicators is particularly important, therefore, because aspects of the urban regeneration process that are interdependent and shared can be highlighted, which mirrors the complex and dynamic systems comprising multiple connections within urban environments (Batty, 2008; Gallopin, 1997; Siniscalco, 2002; Wiek and Binder, 2005). Spending time to think about which indicators to choose at this stage of toolkit development and how they relate to one another, therefore, is crucial, as a poor choice of indicators can make it impossible to achieve some goals around sustainability and urban regeneration (Hunt et al., 2008).

Existing indicators, therefore, are seen as useful 'tools', providing a basis for systematically evaluating topic area-based activities, impacts and concepts (see Hemphill et al., 2004a). To our knowledge, indicators have yet to be used to assess current sustainability solutions in the *future*. To understand how indicators could be used to assess the future of urban environments in terms of sustainable regeneration requires a discussion of future scenarios.

3. Future scenarios

A significant body of work has been published over the last few decades, exploring the use of scenarios in investigating outcomes and implications of different possible futures (see Hunt et al., 2010). The Global Scenarios Group (GSG)—and the associated Tellus Institute—has been instrumental in examining world prospects that have been used by other organisations (e.g., IPCC, OECD, UNEP, US National Academy of Sciences) in making global assessments (Gallopin et al., 1997; Kemp-Benedict et al., 2002; Raskin et al., 1998, 2002). They have developed a broad range of validated scenario visions to address the challenge of sustainable development at the global level, and down-scaled these to specific regions (see Kemp-Benedict et al., 2002). The GSG scenarios focus on quantitative variables across a wide range of socio-economic and environmental factors (e.g., population, economy, environment, equity, technology and conflict), although the scenarios ultimately hinge on imagined, existential responses to present and predictable drivers of change. The result is a defensible and in-depth analysis of different futures that may be used to gain insight into our present understanding of sustainability (Raskin et al., 1998).

The GSG research was a practical starting point for this analysis because their future scenarios are widely used and they can be adapted to the assessment of generic and topic area-specific indicators. In some instances, we added work from other established literature that explored some variables in more depth (e.g., energy, water, waste). From the GSG work, four future scenarios were chosen for the UF project: *Market Forces*, *Policy Reform*, *New Sustainability Paradigm* and *Fortress World*. The first two represent conventional worlds (i.e., relative consistency with current patterns—one might refer to these as extrapolated futures), whereas the last two embody substantial, transformational change of the kind that scenario-building can access, but extrapolation cannot. In the GSG literature, one transformational change scenario is explicitly identified as favourable (i.e., *New Sustainability Paradigm*) and another as undesirable (i.e., *Fortress World*).

As with the scenarios, themselves, the UF project also sought to align itself with GSG in terms of choosing a year on which the future scenarios could be based: 2050. This date was far enough in advance of today that descriptions of the future could be different from how we would describe the present, yet they were not too advanced that decisions being made now in the name of sustainability could not be reasonably assessed via a current set of indicators. Furthermore, because 2050 was chosen as the year that the project 'dropped into', rather than the year that we moved towards, it meant that UF was not concerned with backcasting, or how particular designs, policies and so forth developed or evolved from today to 2050. 'Dropping in' allowed the UF project to view what was happening in particular scenarios without having to identify plausible pathways for getting there beyond those already established by GSG (Raskin et al., 1998).

In terms of the development of the scenarios, they were described first in long paragraph form from the GSG literature, comprising hundreds of pages. To assess and compare the performance of the selected indicators in any significant way, however, requires the scenarios to be more accessible for analysis. To this end, the UF project separated scenario paragraphs into characteristics. The characteristics allow an issue or small set of issues to be written in a bite-sized format for each scenario. For example, we were able to isolate information about population growth in the New Sustainability Paradigm scenario by writing about the issue in one sentence. Using GSG's words: 'Population growth slows, stabilizing at relatively low levels through voluntary reductions in family size in countries with fast growing populations.' This statement, versus a larger paragraph, helps keep characteristics clear, concise and more useful when comparing issues across the scenarios.

Because the UF project focuses on urban regeneration in the UK, the global characteristics then were translated into a 'UK urban' context. This involved finding information from UK-relevant sources (e.g., UK Census, Water UK) and using projections from those sources to create UK urban characteristics. In some cases, the UK urban characteristics were extrapolated, estimated or deduced either from current data available in the UK or from the Western/developed world (the latter was utilised because information was not available at the UK urban scale). For example, one of the characteristics, *health effects of air quality*, used data from DEFRA and estimated relative changes in each scenario, based upon information about particulate matter, NO_2 and ozone. Each scenario includes more than 80 different characteristics.

Once all the scenario characteristics had been created, they were put into a spreadsheet. From here, the characteristics could be queried by issue (e.g., finding all instances of population growth mentioned within the scenarios). Furthermore, comparisons could be made across the scenarios (e.g., how does population growth change between the two transformational scenarios versus the two conventional ones?). To make the scenarios more manageable as a communication device to people both within and outside the UF project, the scenarios were summarised into shorter paragraphs at the UK urban scale, which are discussed below. They also have been put into a table (see Table 2) to show how the scenarios are different, based on key characteristics.

3.1. UK Urban Market Forces

In this scenario, current demographic, economic, environmental, and technological trends unfold without major surprise. The self-correcting logic of the market is expected to cope with problems as they arise, although the elasticity of market-driven control is not infinite. Sustainability issues are addressed more through rhetoric than action. Materialism and individualism spread as core human values, whereas social and environmental concerns are secondary. Competitive, open markets drive development.

In terms of planning, this translates into policy that is generally less prescriptive and more market led, with more freedom about the location and form of new developments (including more domestic water use and less energy-efficient technologies being employed). This results in more land being taken up by the built environment. Brownfield re-development is less likely to be favoured because of the costs of de-contamination and the cheaper cost of green field land. The need for affordable housing increases,

Table 2
Future scenarios at a glance, from a UK urban perspective.

Characteristics[a]	Metric	Market forces	Policy reform	New sustainability paradigm	Fortress world
Main driver	N/A	Competitive, open, global markets	Economic growth with greater equity	Equity and sustainability	Protection of resources by 'haves'; 'have nots' have limited access to them
Population growth	Percentage natural increase + net migration	Decrease	Decrease	Decrease substantially	Increase
Land use	Percentage of land devoted to the built environment	Increase	Increase	Decrease	Increase
Land recycling	Percentage of all new developments built on previously developed land	Decrease	Increase	Increase	Increase in 'have not' areas; unclear in 'have' areas
Need for affordable housing	Percentage of population needing affordable housing	Increase	Decrease	Decrease substantially	Increase substantially for 'have not' areas; decrease substantially for 'have' areas
Civic activism	Percentage of people involved either in direct decision-making about local services or issues, or in the actual provision of services	Decrease	Decrease	Increase substantially	Decrease substantially for 'have not' areas; increase for 'have' areas
Access to public green space	Percentage of population with good access to public green space	Decrease	Increase	Increase	Decrease
Health effects of air quality	Reduction in life expectancy in months	Increase	Decrease	Decrease substantially	Increase
Domestic water withdrawals[b]	Gigalitres per day	Increase	Decrease	Decrease substantially	Decrease
Energy efficient user technologies	Percentage of building stock with highest-efficiency measures	Low	Very high	Very high	Low for 'have not' areas; high for 'have' areas
Planning policy	Strength of policy used in planning	Weak	Strong	Strong	Substantially weak for 'have not' areas; strong for 'have' areas

[a] For all characteristics, there is a comparison with a baseline of today (e.g., population growth in Policy Reform decreases in comparison to today).
[b] The performance of the water withdrawals indicator is based on research by GSG, rather than the Environment Agency study.

as attention is focussed on more niche markets (e.g., luxury flats for couples with no children) at the expense of equality. Access to public green space also will suffer, as such land uses may be converted for development purposes, or may become private or semi-private spaces. Less access to a city's 'green lungs' across the population may lead to poorer respiratory health overall. Such deficiencies, coupled with more individualistic attitudes, may result in low civic activism.

3.2. UK Urban Policy Reform

In this scenario, co-ordinated and comprehensive government action is initiated to reduce poverty and social conflict while enhancing environmental sustainability; market forces are 'encouraged' to produce socially desirable outcomes, but by no means are they silent. Strong policies and growing environmental and social consciousness emerge to support some changes in consumer behaviour. Such policies also slow, but do not reverse, trends towards high distributional inequity that the market alone would do little to address. Tensions still exist between the continued dominance of conventional ideologies and values and the key sustainability goals espoused in the World Commission on Environment and Development (1987) report.

Planning policy is strong in this scenario, with greater regulation of development proposals and a more regional focus than today. This means more land recycling, a stabilisation (or slight increase) of land for built environment purposes, a decrease in the need for affordable housing, greater overall access to public green space, very high uptake of energy efficient user technology and a decrease in the negative health effects from air pollution. Moreover, global population growth decreases, lower domestic water withdrawals. In addition, despite government action to be more sustainable, people are less actively involved in decision-making about local services because policymaking remains top-down and decisions are still made by key, influential people, rather than by a larger majority.

3.3. UK Urban New Sustainability Paradigm

In this scenario, new socio-economic arrangements and fundamental alterations in societal values change the character of civilisation. The conventional notion of progress via economic growth is openly challenged, such that sustainability becomes embedded in decision-makers' thinking about how society grows, and the search for a deeper basis for human happiness and fulfilment is sought. An ethos of 'one planet living' pervades, facilitating a shared vision for a more equitable and sustained quality of life, now and in the future.

Planning policies are highly regulated, emphasising ecological imperatives, regional planning and sustainability. This results in an increase in active land recycling and a decrease in land devoted to the built environment. In addition, there is almost no need for affordable housing, as the urban underclass is eliminated and society is more equitable, and access to public green space is high. Because of strong ecological imperatives, strong regulation and a push for much more renewable energy generation, there is a very high uptake of energy-efficient user technology. In addition, domestic water withdrawals decrease substantially as well as the negative health effects from air pollution. Finally, in line with the idea of 'one planet living', global population growth decreases substantially and civic activism in making areas more liveable increases substantially.

3.4. UK Urban Fortress World

In this scenario, powerful actors organise themselves into alliances in an effort to safeguard their own interests and resources. The world divides into two groups: an authoritarian elite who live in interconnected, protected enclaves controlling access to resources (called the 'haves'), and an impoverished majority outside (called the 'have nots').

Planning policies serve to protect the resources and quality of life of the 'haves' and effectively segregate the 'haves' from the 'have nots'. The built environment sprawls, with the 'haves' gobbling up land for low-density, single-use developments and areas, and the 'have nots' using leftover land to create high-density, mixed-use areas out of necessity. Re-use of land and infrastructure is predominantly by the 'have nots' and is characterised by low-tech recycling and repair rather than remediation and regeneration. Affordable housing is much-needed for 'have nots', but of little or no need for the 'haves', who live in relative luxury. The impoverished majority also are denied access, by spatial and financial patterns, to public green space. In terms of the negative health effects of air pollution, there is a general reduction in life expectancy, as emissions from traffic and other sources cannot be contained to one area. Although NIMBYism drives strong enforcement inside the enclaves and newer technology keeps emissions close to present-day levels, emissions outside the enclaves increase and spread due to poor vehicle maintenance and outdated technology.[3] Furthermore, energy-efficient user technologies are readily adopted in 'haves' areas because they are affordable to this group; the 'have nots', on the other hand, do not use such technologies because they cost too much. Interestingly, even though population growth increases, domestic water withdrawals decrease. This may be due in small part to the use of more energy-efficient technologies by the 'haves' and the restriction of water use for the 'have nots'. Finally, civic activism is not high on the 'have nots' agenda, as their opinions and ideas are not considered in this scenario. However, the 'haves' are more active in civic decision-making, although many of the decisions and policies attempt to exclude the 'have nots' from areas, activities and services.

By identifying a common set of characteristics from these descriptions, it is possible to recognise the direct effect of each scenario on the resulting urban environment. It is important to recognise that the scenarios summarised above represent simply a number of plausible alternative futures and are not linked to current policy or practice. They are not intended to be exhaustive, and no individual scenario is thought to be more probable than any other. Descriptions of the scenarios also may emphasise different perspectives, scales or lenses, depending on what researchers are interested in exploring (e.g., developing world, Africa, Lagos). In the UF project, we were interested in describing the UK context; thus, our scenarios reflect this scale. Finally, scenarios enable the performance of a wide range of indicators to be assessed against a variety of futures that exhibit very different characteristics, thereby allowing the relative vulnerability of any given indicator to be identified.

4. Assessing performance against the future scenarios

Once each of the four scenarios has been described in terms of a set of characteristics as outlined in Section 3 and Table 2, they can be used to assess the relative performance of any given sustainability indicator and to highlight areas of potential vulnerability to different futures. This involves looking back on each set of scenario characteristics and then making assumptions and deductions about the progress towards attainment of the

[3] NIMBY is an acronym for Not In My Back Yard, and refers to "protectionist attitudes of and oppositional tactics adopted by community groups facing an unwelcome development in their neighborhood" (Dear, 1992, p. 288).

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Table 3
Sample of *Urban Futures* indicators and their performance across the scenarios.

Indicator	Question	Metric	Benchmarks	Baseline	MF[a]	PR	NSP	FW 'haves'	FW 'have nots'
Solar access	Are dwellings maximising access to direct sun in winter months so as to reduce space heating demand?	Winter possible sunlight hours[b]	5% (BSI, 1992)	Varies with location.	↓[c]	↑	↑	↑	↓
NO_2 1-h average	Does urban air quality pose a significant risk to human health?	Ambient concentration averaged over 1 h	200 $\mu g\,m^{-3}$	Varies with location.	↑	↓	↓↓	↑	↑

[a] MF: market forces; PR: policy reform; NSP: new sustainability paradigm; FW 'haves': fortress world elite; FW 'have nots': fortress world impoverished.
[b] Percentage of probable sunlight hours received over the winter months, between 23 September and 21 March (British Standards, 1992).
[c] (↑) Increasing in comparison to baseline (today); (↑↑) increasing a lot in comparison to baseline; (–) no change in comparison to baseline; (↓) decreasing in comparison to baseline; (↓↓) decreasing a lot in comparison to baseline.

indicators in each scenario. To standardise the evaluations across scenarios, current conditions are used as a baseline (i.e., UF uses the latest available data from a variety of sources relevant to each topic area). It is important to recognise that, in this analysis, the same indicators are used across the scenarios and the performance of any given indicator in each scenario is judged relative to its baseline. For example, when considering *Solar Access* (SA) as described in Table 3, against the scenario descriptions for *Planning Policy* in Table 2, the likelihood of meeting the benchmark conditions for an important element of that indicator, *Winter Possible Sunlight Hours* (WPSH), will vary across each of the scenarios. This is because the ability to meet such particular requirements will be largely dictated by planning policy, the strength of which will vary both between and within scenarios.

In the UK Urban Market Forces scenario, planning policy is expected to weaken (see Table 2), being driven by the power of the market. Under such conditions the need for the relationship between proximal buildings to be managed to provide SA during winter months, when sun angles are low, is likely to be superseded by a market that seeks to maximise profits from land values, possibly by increasing building densities. Consequently, a development constructed today, whose performance is based on SA could be vulnerable under the Market Forces scenario. Conversely, under UK Urban Policy Reform and UK Urban New Sustainability Paradigm scenarios, planning policy is likely to strengthen (see Table 2) and SA principles are likely to be protected or even privileged. Therefore, a development constructed today, whose performance is based on SA could be resilient under UK Urban Policy Reform and UK Urban New Sustainability Paradigm scenarios. Under the UK Urban Fortress World scenario, the relative vulnerability of SA varies between the 'haves' and 'have nots'. For the 'haves', planning policy will strengthen (see Table 2) and could possibly protect or even privilege the adoption of SA and, hence, access to winter sun. However, for the 'have nots', SA is unlikely to be a conscious feature of the urban environment. Consequently, the resilience of a development constructed today, whose performance is based on SA would vary in a UK Urban Fortress World scenario.

By completing this analysis for all of the identified indicators in each of the scenarios, a broad picture of those aspects of urban regeneration that are particularly vulnerable to changing future conditions can be established. This analysis then can be used to consider how the regeneration process not only can help to deliver actions that are sustainable under today's conditions, but also how they can be made more resilient to help maintain their performance in the future (see Lombardi et al., submitted for publication; Rogers et al., in press, for more information about the resilience of solutions). Using the example from above, it is likely that the ability to maintain the desired SA is going to vary across different scenarios (see Table 3). Consequently, to ensure that the reduction of energy demand through the provision of SA is a robust solution, measures need to be adopted today that help ensure it is maintained in the future. Such measures could include covenants on particular buildings or sites to ensure the spacing between buildings and their relative heights are protected and managed in perpetuity.

In some instances, it is relatively straightforward to deduce performance from the characteristics. However, in other cases the scenarios literature does not provide sufficient depth to describe and, in particular, analyse the characteristics comprehensively. This implies that the scenarios are 'under-characterised', and new characteristics, created from topic area-specific literature, are required before the scenarios can be assessed at the necessary scale.

For example, in trying to assess the performance of two indicators, traffic levels and emissions from traffic, the initial scenario characteristics were insufficient. Further assumptions had to be made, which were, themselves, derived from the scenario characteristics to ensure consistency. Examining UK Urban New Sustainability Paradigm, the following characteristics were noted:

- Public preferences and prices shift to new sustainability technologies.
- A revised tax system and other market signals to discourage environmental "bads" and certain types of consumption.
- The polluter pays principle is universally implemented.
- Integrated settlement patterns place home, work, shops and leisure activity in closer proximity.
- Automobile dependence is reduced radically and a sense of community and connectedness is re-established.
- Lifestyles become less energy intensive while renewable energy resources and highly efficient energy using equipment become the norm.
- Chemical pollution is virtually eliminated with the gradual phase-in of clean production processes.
- Dispersed small towns also become popular as communication and information technologies allow for the decentralisation of activities.
- The migration from rural to urban areas reverses as many opt for the lower stress level and increased contact with nature.

Based on these scenario characteristics, a new characteristic was created that could be used to assess the indicators' performance in the scenario: *Traffic levels decrease and emissions from traffic decrease substantially*. A narrative to accompany this new characteristic was also added: *People are driving less due to integrated settlement patterns—what driving they do has lower emissions per mile due to new sustainability technologies and fines for emissions.* This exercise of using established characteristics, creating new characteristics and making assumptions about the performance of the indicator was repeated for each scenario. Doing so ensures that the characteristics are relevant to a specific, developed world context and are internally consistent.

5. Further development potential

One of the main benefits of using a toolkit such as the one developed above is its flexibility. Although UF explored four scenarios, new scenarios could be added to Table 3 in an effort to investigate more robustly how today's sustainability solutions perform across a broader range of futures (e.g., including GSG's *Breakdown* or *Eco-communalism* variants, Raskin et al., 2002; adding the four scenarios from DTI, 2002).

New characteristics can be added to create a richer picture of the scenarios and so assess the sustainability performance of the scenarios more comprehensively. New characteristics also can be found within the existing scenario characteristics text (e.g., there was information about crop yields in each of the GSG scenarios that was less useful to UF and so left out of the characteristics lists), or deduced from the existing characteristics (e.g., traffic levels illustrated in the previous section).

There also is the option of adding new indicators to the toolkit, again creating a more robust set that could be used to assess the scenarios. The UF indicator set was guided primarily by the project's key topic areas. However, this set could be expanded to include other topic areas pertinent to urban regeneration and sustainability, such as climate change and wellbeing, thus establishing a more holistic and dynamic set of sustainability and regeneration indicators (Bossel, 1999; Robert, 2002; Wiek and Binder, 2005; Yli-Viikari, 2009). Moreover, the set of indicators should reflect local priorities, which includes an understanding of the local community and culture, as community participation in the development and monitoring of indicators is becoming an important issue in the evaluation of indicator effectiveness (Gahin et al., 2003; Rydin et al., 2003). Thus, the toolkit not only helps to assess the performance of today's sustainability solutions in the future, but is capable of being enlarged to suit the needs of researchers, ultimately giving decision-makers a better evidence base with which to support their sustainable urban regeneration decisions.

6. Conclusions

Urban regeneration has always played an important role in national, regional and local economic development, and is often at the heart of delivering targets for sustainable development. However, much of the built environment that results from regeneration programmes has long asset lives, some lasting hundreds of years. Historically, the likely implications of very uncertain future conditions have not been integrated systematically into the design and development processes for regeneration. In some cases, such an omission has not compromised the long-term performance of particular built assets that have continued to function effectively in spite of considerable change. However, in other cases, the failure to adequately consider uncertain future conditions has led to assets prematurely reaching the end of their useful life. Given that urban regeneration plays such a key role in sustainable development policy, it is important to recognise that designing and developing the built environment now, in what we believe to be a sustainable way, does not guarantee the long-term resilience of that environment. Consequently, there is an urgent requirement for tools that enable planners and designers to increase the resilience of urban regeneration investments without incorporating unnecessary redundancy into their designs.

Scenarios are recognised as a useful tool to help think about and visualise the future, yet their potential use in exploring the urban context has not been realised to examine just how 'sustainable' our highly-acclaimed current designs and practices truly are. Through answering the following research question, '*How can the impact of uncertain futures on the performance of different indicators for sustainability in an urban regeneration context be systematically quantified and qualified?*', this paper has discussed a toolkit, developed from the UF project, through which the relative vulnerability or resilience of a range of sustainability solutions can be tested systematically against a number of different futures. Current best-practice guidance, assessment tools and design guides enable all disciplines engaged in the regeneration process to identify the key quantitative or qualitative indicators by which performance of their own solutions can be measured. Such sources also allow the performance of these indicators to be measured relative to best practice targets or intended policy outcomes, but they offer very little in terms of measuring future performance or sensitivity to change. However, by developing the existing scenarios-based literature, it is possible to describe a range of different futures in terms of a number of common characteristics that portray the resulting urban environment and that enable differences between these futures to be compared directly. These characterisations then can be used to consider how the performance of each indicator might be affected by the changes in individual characteristics across all of the futures. Such an analysis provides both an insight into which aspects of performance are vulnerable to change and a feedback mechanism through which solutions currently being implemented can be reconsidered to reduce their vulnerability, making them more resilient in the face of future uncertainty.

An important aspect of the UF methodology underpinning the toolkit is that it is flexible enough to enable new scenarios, characteristics and indicators to be evaluated systematically. New characteristics could be added that create a richer picture of the scenarios and, therefore, have the potential to provide more accuracy when assessing the performance of the scenarios. These new characteristics could be found within the already-existing scenario characteristics text or deduced and assumed from an array of established characteristics. Also, new indicators could be added, thereby creating a more holistic and dynamic evaluation that is sensitive to the local context. Thus, the toolkit not only helps to assess the performance of today's sustainability solutions in the future, but is capable of being enlarged to suit the needs of different research or decision-making perspectives.

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References

Alberti, M., 1996. Measuring Urban Sustainability. Environmental Impact Assessment Review 16 (4–6), 381–424.
Audit Commission, 2000. Getting Better All the Time: Making Benchmarking Work. HMSO, London.
Audit Commission, 2009. Best Value Performance Indicators 2007/2008. HMSO, London.
Audit Commission and Improvement and Development Agency (IDeA), 2002. Acting of Facts: Using Performance Measurement to Improve Local Authority Services. HMSO, London.
Batty, M., 2008. The size, scale, and shape of cities. Sciences 319, 769–771.
Berkhout, F., van Drunen, M., 2007. Socio-economic Scenarios in Climate Change Research: A Review (Report W-07/07). VU University Amsterdam, Institute for Environmental Studies, Amsterdam.
Bossel, H., 1999. Indicators for Sustainable Development: Theory, Methods, Applications. International Institute for Sustainable Development, Winnipeg, Canada.
Bradford, W., Bridgeman, J., Gaterell, M.R., 2010. A Review of the 1892 water demand forecast for Birmingham. Engineering History and Heritage 163 (1), 39–49.
British Standards Institution (BSI), 1992. BS 8206-2: 1992. Lighting for Buildings. Code of Practice for Daylighting. BSI, London.

Bryson, J.R., 2007. Arts, dance, cultural infrastructure, and city regeneration: knowledge, audience development, and conventions, and the relocation of a royal ballet company from London to Birmingham. Norwegian Journal of Geography 61 (3), 98–110.
Bullock, N., 2002. Building the Post-war World: Modern Architecture and Reconstruction in Britain. Routledge, London.
Burns, R.B., 2000. Introduction to research methods. Sage, London.
Catney, P., Lerner, D.N., 2009. Managing multidisciplinarity: lessons from SUBR:IM. Interdisciplinary Science Reviews 34 (4), 290–308.
Dear, M., 1992. Understanding and overcoming the NIMBY syndrome. Journal of the American Planning Association 58 (3), 288–300.
Department for Communities and Local Government (DCLG), 2007b. Planning Policy Statement 3 (PPS3): Housing. HMSO, London.
Department for Communities and Local Government (DCLG), 2008. The Code for Sustainable Homes: Setting the Standard in Sustainability for New Homes. HMSO, London.
Department for Communities and Local Government (DCLG), 2009. Transforming Places; Changing Lives. A Framework for Regeneration. HMSO, London.
Department for Environment, Food and Rural Affairs (DEFRA), 2007. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, vol. 1. DEFRA, London.
Department for Environment, Food and Rural Affairs (DEFRA), 2009. Sustainable Development Indicators for Your Pocket 2009. DEFRA, London.
Department of the Environment (DoE), 1994. Sustainable Development: The UK Strategy. HMSO, London.
Department of the Environment, Transport and the Regions (DETR), 1999. Sustainability Strategy for the UK: A Better Quality of Life. HMSO, London.
Department of Trade and Industry (DTI), 2002. Future Foresight 2020: Revised Scenarios and Guidance. Office and Science and Technology, DTI, London.
Dovey, K., Sandercock, L., 2002. Hype and hope. Imagining: Melbourne's docklands. City 6 (1), 83–101.
Environment Agency, 2009. Water Resources Strategy for England and Wales. Environment Agency, Bristol.
Evans, G., 2005. Measure for measure: evaluating the evidence of culture's contribution to regeneration. Urban Studies 42 (5/6), 959–983.
Evans, R., Marvin, S., 2006. Researching the sustainable city: three modes of interdisciplinarity. Environment and Planning A 38, 1009–1028.
Gahin, R., Veleva, V., Hart, M., 2003. Do indicators help create sustainable communities? Local Environment 8 (6), 661–666.
Gallopin, G.C., 1997. Indicators and their use: information for decision-making. In: Moldan, B., Billharz, S. (Eds.), Sustainability Indicators: Report of the Project on Indicators of Sustainable Development. Wiley, London.
Gallopin, G., Hammond, A., Raskin, P., Swart, R., 1997. Branch Points: Global Scenarios and Human Choice. Stockholm Environment Institute, Stockholm.
Green Building Council of Australia, 2010. Green Star. Available at http://www.gbca.org.au/green-star/ (Accessed 09.09.10).
Hakim, C., 2000. Research Design: Successful Designs for Social and Economic Research. Routledge, London.
Halliday, S., 2001. The Great Stink of London: Sir Joseph Bazalgette and the Cleansing of the Victorian Metropolis. Sutton, Stroud.
Hammond, A., Adriaane, A., Rodenburg, E., Bryant, D., Woodward, R., 1995. Environmental Indicators: A Systematic Approach to Measuring and Reporting on Environmental Policy Performance in the Context of Sustainable Development. World Resources Institute, Washington, DC.
van der Heijden, K., 1997. Scenarios, Strategies and the Strategy Process. Nijenrode Research Paper Series (No. 1997-01) Nijenrode University, Breukelen, NL.
Hemphill, L., Berry, J., McGreal, S., 2004a. An indicator-based approach to measuring sustainable urban regeneration performance: part 1, conceptual foundations and methodological framework. Urban Studies 41 (4), 725–755.
Hemphill, L., Berry, J., McGreal, S., 2004b. An indicator-based approach to measuring sustainable urban regeneration performance: part 2, empirical evaluation and case-study analysis. Urban Studies 41 (4), 757–772.
Hezri, A.A., Dovers, S.R., 2006. Sustainability indicators, policy and governance: issues for ecological economics. Ecological Economics 60 (1), 86–89.
Hunt, D.V.L., Lombardi, D.R., Rogers, C.D.F., Jefferson, I., 2008. Application of sustainability indicators in decision-making processes for urban regeneration projects. Engineering Sustainability, Proceedings of the Institution of Civil Engineers 161 (1), 77–91.
Hunt, D.V.L., Lombardi, D.R., Atkinson, S., Barber, A., Barnes, M., Boyko, C., Brown, J., Bryson, J., Butler, D., Caputo, S., Caserio, M., Coles, R., Farmani, R., Gaterell, M., Hale, J., Hales, C., Hewitt, N., Jankovic, L., Jefferson, I., MacKenzie, R., Memon, F., Pugh, T., Rogers, C.D.F., Smith, D., Whyatt, C., Weingaertner, C., 2010. Using Scenarios to Explore Urban UK Futures: A Review of Futures Literature from 1997–2010. Urban Futures Working Paper Series (No. 1) University of Birmingham, Birmingham.
Imrie, R., Thomas, H., 1995. changes in local governance and their implications for urban policy evaluation. In: Hambleton, R., Thomas, H. (Eds.), Urban Policy Evaluation: Challenge and Change. Paul Chapman Publishing, London, pp. 123–138.
Innes, J., Booher, D., 1999. Metropolitan development as a complex system: a new approach to sustainability. Economic Development Quarterly 13 (2), 141–156.
Japan Sustainable Building Consortium, 2010. CASBEE. Available at http://www.ibec.or.jp/CASBEE/english/index.htm (Accessed 09.09.10).
Joint Nature Conservation Committee, 2009. Conservation Volunteering. Available at http://jncc.defra.gov.uk/page-4253 (Accessed 23.09.09).
Jones, P., Evans, J., 2008. Urban Regeneration in the UK. London, Sage.
Kang, C.D., Cervero, R., 2009. From elevated freeway to urban greenway: land value impacts of the CGC project in Seoul, Korea. Urban Studies 46 (13), 2771–2794.
Kärrholm, M., 2011. The scaling of sustainable urban form: a case of scale-related issues and sustainable planning in Malmö, Sweden. European Planning Studies 19 (1), 97–112.
Kemp-Benedict, E., Heaps, C., Raskin, P., 2002. Global Scenarios Group Futures: Technical Notes. Stockholm Environment Institute, Stockholm.
Llewelyn-Davies, 2000. Urban Design Compendium, 2nd ed. Llewelyn-Davies, London.
Lombardi, D.R., Hale, J., Rogers, C.D.F. Testing the future resilience of a sustainability solution: mixed-use development. Planning, Theory and Practice, resubmitted for publication.
Maclaren, V., 1996. Urban sustainability reporting. Journal of the American Planning Association 62 (2), 184–202.
Moss, R.H., Edmonds, J.A., Hibbard, K.A., Manning, M.R., Rose, S.K., van Vuuren, D.P., Carter, T.R., Emori, S., Kainuma, M., Kram, T., Meehl, G.A., Mitchell, J.F.B., Nakicenovic, N., Riahl, K., Smith, S.J., Stouffer, R.J., Thomson, A.M., Weyant, J.P., Wilbanks, T.J., 2010. The next generation of scenarios for climate change research and assessment. Nature 463 (7282), 747–756.
Nakicenovic, N., Swart, R. (Eds.), 2000. Special Report on Emissions Scenarios (for the Intergovernmental Panel on Climate Change). Cambridge University Press, Cambridge.
Natural England, 2008. Understanding the Relevance and Application of the Access to Natural Green Space Standard. Natural England, London.
Office of National Statistics (ONS), 2002. People's Perceptions of their Neighbourhood and Community Involvement. Results from the Social Capital Module of the General Household Survey 2000. The Stationery Office, London.
Office of the Deputy Prime Minister (ODPM), 2005a. Planning Policy Statement 1: Delivering Sustainable Development. HMSO, London.
Office of the Deputy Prime Minister (ODPM), 2005b. Sustainable Communities: People, Places and Prosperity. HMSO, London.
Office of the Deputy Prime Minister (ODPM), 2006. Securing the Future: Delivering UK Sustainable Development Strategy. HMSO, London.
Pagina, W., 2000. Measurement and Indicators for Sustainable Development. International Institute for Sustainable Development, Winnipeg, Canada.
Pannell, D.J., Glenn, N.A., 2000. A framework for the economic evaluation and selection of sustainability indicators for agriculture. Ecological Economics 33 (1), 135–149.
Pannell, D.J., Schilizzi, S., 1999. Sustainable agriculture: a question of ecology, equity, economic efficiency or expedience? Journal of Sustainable Agriculture 13 (4), 57–66.
Petts, J., Owens, S., Bulkeley, H., 2008. Crossing boundaries: interdisciplinarity in the context of urban environments. Geoforum 39, 593–601.
Qviström, M., Saltzman, K., 2006. Exploring landscape dynamics at the edge of the city: spatial plans and everyday places at the inner urban fringe of Malmö, Sweden. Landscape Research 31 (1), 21–41.
Raskin, P., Gallopin, G., Gutman, P., Hammond, A., Swart, R., 1998. Bending the Curve: Toward Global Sustainability. Stockholm Environment Institute, Stockholm.
Raskin, P., Banuri, T., Gallopin, G., Gutman, P., Hammond, A., Kates, R., Swart, R., 2002. Great Transitions: The Promise and Lure of the Times Ahead. Stockholm Environment Institute, Stockholm.
Raskin, P., Monks, F., Ribeiro, T., van Vuuren, D., Zurek, M., 2005. Global scenarios in historical perspective. In: Carpenter, S.R., Pingali, P.L., Bennett, E.M., Zurek, M. (Eds.), Scenarios (for the Millennium Ecosystem Assessment). Ecosystems and Human Well-being, vol. 2. Island Press, Washington, DC, pp. 35–44.
Ravetz, J., 2000. City Region 2020: Integrating Planning for a Sustainable Environment. Earthscan, London.
Robert, K.H., 2002. The Natural Step Story: Seeding a Quiet Revolution. New Society Publishers, Gabriola Island, Canada.
Roberts, P., Sykes, H., 2000. Urban Regeneration: A Handbook. Sage, London.
Rogers, C.D.F., Lombardi, D.R., Leach, J.M., Cooper, R.F.D., Inman, J., accepted, 2012. The urban futures methodology applied to urban regeneration. Engingeering Sustainability164, ES4.
Roper, S., Hales, C., Bryson, J.R., Love, J., 2009. Measuring Sectoral Innovation Capability in Nine Areas of the UK Economy. NESTA, London.
Rotmans, J., van Asselt, M., Anastasi, C., Greeuw, S., Mellors, J., Peters, S., Rothman, D., Rijkens, N., 2000. Visions for a sustainable Europe. Futures 32 (9–10), 809–831.
Rydin, Y., Holman, N., Wolff, E., 2003. Local sustainability indicators. Local Environment 8 (6), 581–589.
Schwartz, P., 1996. The Art of the Long View: Planning for the Future in an Uncertain World. Doubleday, New York.
Shin, J-H., Lee, I-K., 2006. Cheong Gye Cheon restoration in Seoul, Korea. Civil Engineering 159 (4), 162–170.
Siniscalco, D., 2002. Chair's Conclusions. In: Organization for Economic Co-operation and Development (OECD) (Eds.), Towards Sustainable Development. Indicators to Measure Progress. Proceedings of the OECD Rome Conference. OECD, Paris, pp. 13–16.
Sommer, F., 2000. Monitoring and evaluating outcomes of community involvement: the LITMUS experience. Local Environment 5 (4), 483–491.
Southworth, M., Ruggeri, D., 2011. Beyond placelessness: place identity and the global city. In: Banerjee, T., Loukaitou-Sideris, A. (Eds.), Companion to Urban Design. Routledge, Oxon, Oxford, pp. 495–509.
Tunstall, D., 1992. Developing Environmental Indicators: Definitions Framework and Issues. Background Materials for the World Resources Institute

Workshop on Global Environmental Indicators. World Resources Institute, Washington, DC.
Tunstall, D., 1994. Developing and Using Indicators of Sustainable Development in Africa: An Overview. In: Proceedings from the Network for Environment and Sustainable Development in Africa (NESDA). NESDA, Banjul, The Gambia.
Turok, I., 1989. Evaluation and understanding in local economic policy. Urban Studies 26 (6), 587–606.
U.S. Green Building Council, 2010. LEED. Available at http://www.usgbc.org/DisplayPage.aspx?CategoryID=19 (Accessed 09.09.10).
Vedung, E., van der Doelen, F.C.J., 1998. The sermon: information programs in the public policy process—choice, effects, and evaluation. In: Bemelmans-Videc, M.-L., Rist, R.C., Vedung, E. (Eds.), Carrots, Sticks & Sermons: Policy Instruments and their Evaluation. Transaction Publishers, New Brunswick, NJ, pp. 103–128.
Water UK, 2009. Sustainability Indicators 2008/9. Water UK, London.
Wiek, A., Binder, C., 2005. Solution spaces for decision-making—a sustainability assessment tool for city-regions. Environmental Impact Assessment Review 25, 589–608.
Wood, S., 2009. Desiring docklands: deleuze and urban planning discourse. Planning Theory 8 (2), 191–216.
Wolfe, T., 1981. From Bauhaus to Our House. Bantam Books, New York.
World Commission on Environment and Development (WCED), 1987. Our Common Future. Oxford University Press, Oxford.
Wong, C., 2002. Developing indicators to inform economic development in England. Urban Studies 39 (10), 1833–1863.
Yli-Viikari, A., 2009. Confusing messages of sustainability indicators. Local Environment 14 (10), 891–903.