Future Proofing the Benefits of Urban Tree Planting

Abstract

It is clear that urban tree planting can result in a range of improvements to city performance, yet the complexity of urban systems threatens the success of such ventures. How can we ensure that the benefits of tree planting are sustained in the long term when we cannot predict with any accuracy what the future will hold? The Urban Futures methodology has been applied to identify the systems that support urban trees and their dependencies and vulnerabilities with a view to improving the resilience of their intended benefits. It explicitly links each benefit to a set of necessary conditions and tests these against a variety of future urban scenarios. The result of this analysis is the identification of themes that deserve particular attention if the resilience of urban tree planting is to be improved.

Introduction

Cities, Sustainability and Resilience

The global population is urbanising, and cities are at the centre of debates about sustainability, wellbeing and resilience (Grimm *et al.,* 2008; Ernstson *et al.,* 2010). Urban populations ultimately drive much of the global demand for resources, but their users may also be subjected to poor environments, cramped living conditions, and have restricted access to services as a result of modern patterns of land use, transport and consumption. Cities therefore create a market for a bewildering array of 'sustainability solutions' aimed at improving wellbeing whilst reducing environmental impacts and increasing resource security. Such solutions are adopted at multiple scales and by a variety of actors; for example, mobile applications may be downloaded by individuals seeking a low-pollution cycle route to work (Walkit, 2014), housing associations may install solar water heating to reduce energy costs for their tenants and local authorities may initiate the large-scale insulation of residential houses to reduce urban CO_2 emissions.

Amid this rush to develop more sustainable cities, questions have been raised about whether products and services labelled as 'sustainable' are always beneficial (Parguel *et al.,* 2011). Audits of sustainability performance are therefore common (BREEAM, 2014), with an array of related indicators and accreditation schemes. Such scrutiny has tended to be confined to the planning and construction phases of a project (Lombardi *et al.,* 2011). However, more recently, concerns have been raised about the longevity of sustainability solutions (Rogers *et al.,* 2012). Many new technologies and practices are difficult to evaluate in this respect, given the short timeframe within which data has been available. However, it appears that many solutions are installed without clear expectations about their lifespan and without certainty about management responsibilities or even basic performance criteria. Moreover, high-profile failures of sustainability solutions (Lombardi *et al.,* 2012) risk putting off early adopters from installing related (but more effective) solutions. Given the scale of investment that is underway, greater consideration of the long-term performance of these solutions is clearly needed.

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sustainability,
systems

James D. Hale[1], Dexter V.L. Hunt[1], Thomas A.M. Pugh[2], A. Robert MacKenzie[1], Jon P. Sadler[1], Christopher D.F. Rogers[1] and the Urban Futures team

[1] University of Birmingham, Birmingham United Kingdom

[2] Karlsruhe Institute of Technology, Germany

Urban systems are highly complex and may change rapidly. Land cover, land use, populations, community values and behaviour are all in a state of flux and are often difficult to control, monitor or predict. This may explain why some sustainability solutions are being put in place with little consideration of their legacy; how can they be designed for a future that is so uncertain? This therefore raises questions about functional resilience within urban systems, although definitions of resilience vary (Holling, 1996; Carpenter *et al.,* 2001). In this paper, we adapt the definition used by Gunderson (2001) and consider resilient sustainability solutions to be those whose benefits remain essentially the same despite changes to the urban system in which they are embedded.

Urban Futures

The following analysis explores some of these issues in the context of urban trees. It is based upon research undertaken within Urban Futures, a multi-disciplinary project funded by the UK Engineering and Physical Sciences Research Council (EPSRC), which developed a methodology to examine the vulnerability of today's sustainability solutions. The goal of this methodology is to ensure that solutions continue to deliver sustainability benefits whatever the future holds by testing their vulnerability against a variety of future urban scenarios. Further details, applications and example analyses can be found in the special issue of *Proceedings of ICE Engineering Sustainability* (Vol. 165, issue 1, 2012) and in *Designing Resilient Cities: A Guide to Good Practice* (Lombardi *et al.,* 2012).

Urban Trees and Sustainability

Urban tree planting could be considered the archetypal urban sustainability solution, as it is broadly recognised, desired and applied. Despite this it is not always successful, even in the short term (Figure 1). The issues surrounding trees in cities are also relevant to discussions about 'wicked problems' in urban environmental management (Gaston, 2010). For example, it is difficult to be certain about what problems urban tree planting is solving, whether or when these problems have been solved and what the unintended impacts have been. Despite these uncertainties, there still appears to be a strong appetite for urban tree planting and a strong awareness about its many potential benefits. This is reflected in the various 'million tree' initiatives (Pincetl, 2010) that commit local governments to large-scale urban tree planting, but also in the apparent default position that urban regeneration proposals must include some tree planting or other vegetation.

Figure 1: Three urban trees with contrasting fortunes: A) a tree that died less than one year after planting as part of a new urban street development, B) a mature tree removed to facilitate the installation of a new pedestrian crossing, C) apparently healthy trees less than three years after planting as part of a new residential development

Here, we demonstrate how the Urban Futures (UF) methodology can be used to clarify the 'problems' that urban tree planting is trying to solve, identify the system conditions that need to be present for a particular benefit to be delivered and test whether a benefit is heavily dependent on how the city develops in the future.

Methods

Solutions, Benefits and Necessary Conditions

We define a sustainability solution as any intervention that has clear potential to deliver key sustainability goals. Step one of the UF methodology requires the solution and its intended benefits to be clearly stated (Lombardi *et al.,* 2012). For this paper, we have chosen to analyse a relatively common sustainability solution – a proposal to plant a line of street trees as part of a new residential development.

Urban trees may potentially deliver a range of sustainability benefits (Roy *et al.,* 2012), which vary depending on the nature of the trees themselves as well as their built, environmental and social context. Our analysis of the generic solution of 'planting a line of street trees' is therefore unlikely to give the same results as an analysis that considers trees in a specific development proposal. Despite this, we have identified a range of benefits that might be expected in UK urban areas, such as summertime cooling, the interception of air pollutants and visual amenity (Figure 2).

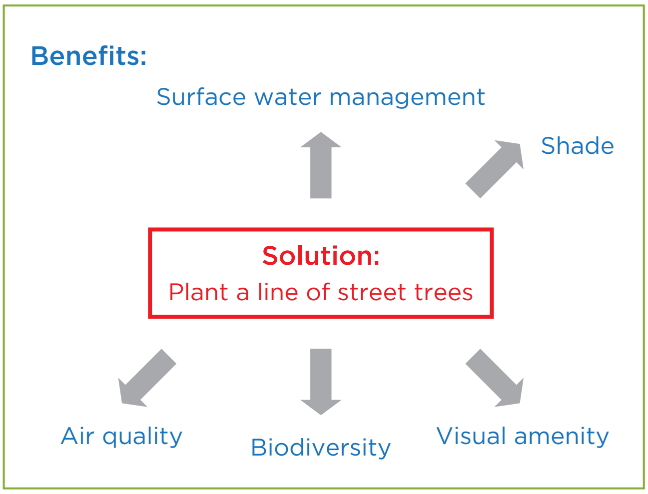

Figure 2: A selection of potential benefits associated with planting a row of street trees

Whether each benefit will be delivered depends on a set of conditions, which may relate to issues such as the maintenance of the solution, its level of protection and even how it is perceived by the local community. Step two of the UF methodology requires these necessary conditions to be identified for each intended benefit in turn. Here, we demonstrate this step using the intended benefit of visual amenity. At a basic level, the tree needs to be present and visible to the public. Obvious perhaps, but small trees surrounded by signage, street furniture and buildings may be effectively invisible. It is clear that views of trees are valued by many people, and a range of research has demonstrated various psychological benefits that can result from visual access to vegetation (Kaplan, 2001). However, one might expect these positive associations to be tempered by negative experiences or cultural associations with trees. Whether the trees will create a visually appealing streetscape will therefore depend on a range of conditions relating to the form and visibility of the trees, and the proximity of local people and their unique psychological responses to urban vegetation (Figure 3).

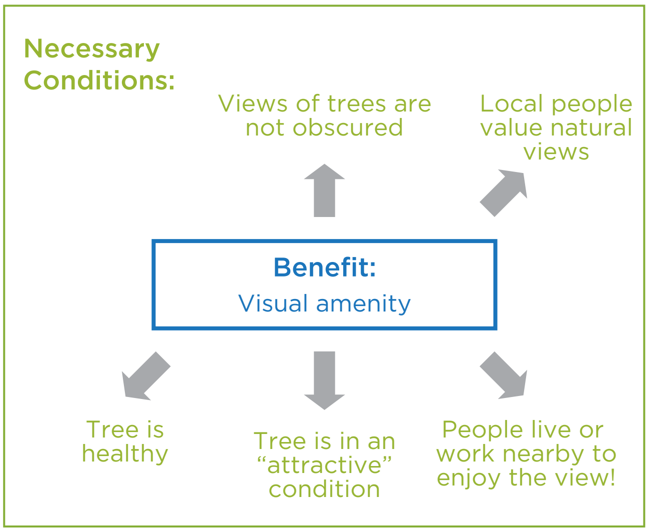

Figure 3: A selection of conditions that may be necessary for street trees to deliver visual amenity

Urban Scenarios

The final stage of the UF methodology is to consider whether these necessary conditions are likely to be supported in the future, and if not, why not? All predictions of the future will be inaccurate at some level, so the UF methodology employs four contrasting future scenarios for UK urban areas. These include conventional scenarios that are currently recognisable in many UK cities, and also more extreme but plausible visions of urban futures. By questioning whether these necessary conditions would be supported in each future, we are able to expose vulnerabilities that can then be addressed. Four scenarios were adapted from the Global Scenarios Group (GSG, 2014) scenario set to reflect the characteristics of UK urban areas. These have been extensively described elsewhere (Rogers *et al.*, 2012; Lombardi *et al.*, 2012), but are summarised below.

Market Forces – Competitive, open and integrated global markets drive world development. Social and environmental concerns are secondary, and consumerism, materialism and individualism spread as core human values. Income disparity is high.

Policy Reform – Improved social equity and environmental protection are achieved through vigorous policy initiatives. Social goals are prioritised over environmental goals, with consumerism and individualism still ubiquitous. Income disparity is reduced.

Fortress World – A highly divided society driven by resource and personal security. Alliances protect the privileges of rich and powerful elites, with the poor majority isolated from all but essential services and resources.

New Sustainability Paradigm (NSP) – A more humane and equitable society driven by social values that support equity and sustainable development. Greater awareness and willingness to pay for environmentally sensitive practices, combined with greater civic participation.

Results

In practice, this analysis needs to be repeated for each intended benefit. However, for brevity, the results for a single benefit (visual amenity) are presented. In a future scenario where Market Forces dominate, street trees may fail to deliver visual amenity due to the removal of the trees themselves. Tree maintenance and protection are not priorities in this scenario, with trees much less likely to mature into highly visible specimens. Trees in densely built areas or places with high land values might be particularly vulnerable to removal in order to reduce the risk of damage to buried infrastructure, to reduce litigation risks or simply to facilitate development. In addition, within this scenario residents are less likely to value (and therefore protect) natural views. Under a Policy Reform scenario, large (and therefore visible) trees have better protection, but may still be vulnerable where they damage buried infrastructure. The visibility of street trees is higher due to mixed-use development, but more compact urban forms increase the risk of water stress, causing unattractive canopy damage. Within the highly polarised scenario of Fortress World, street trees are generally unprotected and are vulnerable to felling for fuel. Pollution and water stress compromise tree health in deprived parts of the city, whilst street trees are valued and protected in areas used by the rich elite. The retention of street trees and the protection of their visibility are much more likely within the NSP scenario, where damage to pavements and risks to infrastructure are considered necessary costs.

Discussion

The loss of maintenance budgets is a feature of the Market Forces and Fortress World scenarios and suggests that urban street trees that rely on supplementary watering may not be particularly resilient. The use of technologies to reduce conflicts with buried infrastructure would make it more likely that larger and therefore more visible trees are tolerated in these scenarios. Perhaps most interesting is the potential impact of high-density development within the Market Forces and Policy Reform scenarios on tree visibility and attractiveness. This suggests that for visual amenity to be delivered in these scenarios, particular attention should be paid to locating street trees to maximise visibility and to ensuring that trees have access to surface water flows.

Although many of these results are intuitive, others may be unexpected and may flag up areas where practice could be improved. However, it is possible that the *process* of undertaking this analysis may be more valuable than the results themselves. This approach forces the user to explicitly question what they are trying to achieve with any given sustainability solution. It makes many assumptions explicit, highlights risks in a structured way and can act as a starting point for improving the resilience of each intended benefit.

'Sustainability solutions' are not intrinsically sustainable, and their performance depends greatly on their context and whether key conditions are retained over time. Many such solutions are installed on the assumption that maintenance budgets or social values will support these solutions in the long term, but to be resilient they must function even in futures that are indifferent or even hostile to their presence. For urban tree planting campaigns to succeed, they need to be challenged to demonstrate that the longevity of the trees has been considered, along with whether the expected benefits are future proof. Clearly, we need to protect urban trees over long time scales, but this is not sufficient. We also need to identify and protect the broader systems that will allow these trees to deliver their potential benefits into the future.

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