FUTURE PROVES PAST: LESSONS LEARNED AND FUTURE INNOVATIONS FOR URBAN TREES AND GREENERY

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Abstract

Trees and urban greenery are quietly transforming many Australian cities. A growing understanding of their benefits is fuelling a groundswell of positive change. Urban greenery is becoming a critical tool in urban, environmental and natural resource planning. Strategically planted trees and other greenery can combat heat islands, improve social inclusion, increase sense of place, enhance property values and more. This paper reviews discoveries and innovations from the study and use of urban trees and other greenery. It documents key lessons from national and international experience over the past 15 years. It goes on to outline some future trends, directions and applications for urban trees and greenery. Topics of discussion include species selection, passively enhancing childhood health and improving older people's comfort and social experience.

Introduction

Trees and urban greenery are quietly transforming cities in Australia and overseas. A growing understanding of the benefits of these natural assets is fuelling a groundswell of positive change. The trend towards strategic greening is a quiet revolution in urban planning and design. Green infrastructure – including street trees, green roofs, vegetated surfaces and green walls – is becoming a critical tool in urban, environmental and natural resource planning internationally. A growing volume of reliable empirical evidence and technical experience drives the current emphasis on the strategic use of trees and urban greenery. This progress stems from a lengthy research and development journey that began in earnest about 15 years ago. Many discoveries were made along the way, generating empirical data and technical guidance that would go on to inform policy and practice. This paper documents key lessons from national and international experiences of contemporary green infrastructure research since its substantive emergence in the mid-2000s. It also outlines future trends, directions and applications for urban trees and greenery beyond 2020.

Lessons to date

There is nothing self-evident about the concept of green infrastructure. Defining the concept correctly was an early problem. Different disciplines attached their own environmental, political, social and economic meanings, with little agreement as to how the concept should be defined and interpreted (Wright, 2011). This definitional ambiguity affected how different actors conceptualized green infrastructure. This created an early barrier, frustrating its adoption as a strategic urban intervention (Matthews, Lo & Byrne, 2015). An early perspective on green infrastructure that found good traction explicitly distinguished between green-space as an amenity and green infrastructure as a necessity (Benedict and McMahon, 2006). Defining green infrastructure as a necessity accentuated its wide strategic benefits and insulated early efforts against the uncertain political status of green-space planning more generally (Matthews, Lo & Byrne, 2015). Over time, the worlds of research and practice came to commonly understand green infrastructure as a network of green-spaces, interconnected and multifunctional, strategically planned and managed to provide ecological, social, and economic benefits. This view, moulded and shaped by experience, agreeably represented the intentional character of green infrastructure as a strategic intervention in built environments.

The first decade or so of research into green infrastructure focused on heavily identifying and quantifying its services and benefits. These were categorised primarily around the pillars of sustainability – economy, society and environment (Roy, Byrne & Pickering, 2012). While benefits sometimes occur in one domain, they can occur in multiple domains simultaneously. For example, street trees, parks and other form of green infrastructure can reduce ambient air temperatures. Temperature reduction can increase in line with overall volumes of greenery. A 5% increase in tree cover can reduce daytime temperature by as much as 2.3°C (Byrne *et al*., 2015). This is a principally an environmental benefit, though it co-produces benefits in other domains. For example, lower temperatures can increase residents' physical activities and mental health, improve social interactions and reduce heat-related burdens on healthcare systems.

Green roofs and walls can naturally cool buildings, substantially lowering demand for air conditioning, along with associated operational costs. They also provide habitat for wildlife, recreational opportunities for people, better management of storm water runoff and improved urban aesthetics. Good quality and plentiful greenery in neighbourhoods can increase property values, though this raises the possibility of eco-gentrification (Ambrey *et al.*, 2017). Street trees, parks and other green-spaces also tend to increase residents' levels of physical activity and social interactions and can promote public transport use. Conversely, low levels of urban greenery may intensify urban heat island effects, thus impeding social interactions and neighbourliness. Influences on crime and incivility were also investigated. For example, Burley (2018) showed that that an increase in new urban trees is associated with reductions in violent crime. Research now confirms that access to nature in urban settings has a mitigating impact on violence (Shepley *et al.*, 2019).

Notwithstanding the positive services offered by green infrastructure, research over the last 15 years or so also identifies disservices. One is 'thermal inequality', a concept that describes how less affluent people are often concentrated within suburbs where houses are packed closer together with fewer trees (Byrne *et al.*, 2016). Many are also renters, giving them no agency to install insulation or solar power. This leaves no option except to increase air conditioning use, leading to inflated power bills. Excessive heat where greenery is lacking can also increase health-care expenses and reduce productivity for residents or workers in the area. Other known disservices of green infrastructure are human-wildlife conflict, reduced groundwater, pest species, increased allergies and damage from root encroachment or branch drop (Roy, Byrne and Pickering, 2012).

Table 1. *Synthesis of urban greenery benefits, adapted from Roy, Byrne & Pickering (2012)*

Environmental	Social	Economic
Regulate ambient temperatures	Relieve stress	Reduce stormwater costs
Reduce noise	Reduce morbidity and mortality	Reduce cooling costs
Lower wind speeds	Foster active living	Decrease health-care expenses
Sequester carbon	Encourage social interaction	Increase property values
Attenuate runoff	Moderate incivility	
Enhance/augment habitats		

Looking ahead

Debate continues on the exact nature and character of green infrastructure. New, more nuanced definitions continue to be advanced (e.g. Matthews, Lo & Byrne, 2015; Mell *et al.*, 2013). Contemporary conceptualisations depict green infrastructure as biological resources in urban areas, which are human-modified, primarily serve an overt ecological function and are intentionally designed for widespread public use and benefit. These perspectives recognise that green infrastructure combines socio-political and biophysical elements and is not simply a technical or design intervention. The intent is to improve clarity around the ways biological interventions are intentionally deployed to connect nature, space and culture to produce co-benefits.

Concerns around green infrastructure governance remain unresolved after many years of research. In particular, questions persist about who owns, manages and is liable for it – something which can change profoundly according to context, time and tenure. Effective governance mechanisms for green infrastructure are essential because it is fundamentally different to any other infrastructure. Trees and other forms of urban greenery are alive and have agency. Their existence is dynamic. Changes in their morphology and form over time may impact upon other urban services. A street tree may give wonderful shade, but it may quickly become a problem if its roots disrupt subterranean services and utilities, or branches drop on pedestrians. Many planners and policymakers see the potential value of green infrastructure. However, they caution that delivering the technology can be an uncertain process due to various institutional, legal, economic, social and environmental challenges (Matthews, Lo & Byrne, 2015). Establishing workable governance arrangements remains a challenge. In this regard, there is an ongoing divide between research identifying values of green infrastructure and professional experience of delivering and maintaining it.

An important area of current and future attention in green infrastructure research is monetary valuation techniques. These put a dollar value on otherwise un-priced natural resources like urban greenery (Horwood, 2011). Putting a price on trees and other natural elements is a pragmatic act (Lo, 2012). Doing so can provide a common currency for comparing green infrastructure with other forms of infrastructure in planning and development decisions. Monetary valuation techniques can facilitate objective evaluations through scientific assessments of economic benefits and costs. This approach offers a rational basis for green-space planning and management that is based on established monetary values (Plant, Rambaldi & Sipe, 2016). A further avenue for this type of research is to establish the monetary value of existing green spaces via public use. Having a monetary expression of this value would allow for more sophisticated cost-benefit analyses to occur in any instance where that space was considered for alternative forms of development.

There are other new and exciting frontiers currently emerging in green infrastructure research. Many of the discoveries of the past 15 years are now being refined, leaving room for new enquiries into the future. Examining the capacity of green infrastructure to improve the experiences of certain cohorts is becoming an important new line of enquiry. For example, there is an urgent need to plan towns and cities to better meet the needs of aging populations in many countries. Improvements include better walkability and more attractive public spaces that use greenery to provide shade and improve the thermal comfort and social experience of seniors. There is a knowledge gap about the role that green infrastructure can play in mitigating heat to improve quality of life, wellbeing and health among older people (Baldwin, Matthews & Byrne, 2020). Children are emerging as another cohort of interest in green infrastructure research. Children are particularly vulnerable to the adverse effects of the urban environment because of their developing organ systems and behavioural interaction with their environment. Dedicated studies are already reporting the influences green space exposure has children's health and developmental outcomes (Hunter *et al.*, 2019; Islam, Johnson & Sly, 2020).

Future proves past

The scale and breath of green infrastructure research in 2020 is the result of a quiet revolution. This grew over time, forged international connections, produced innovative discoveries and connected research to practice in exciting ways. The extensive knowledge generated and practical uptake of green infrastructure over the past 15 years is nothing short of amazing. Research first began with the intention of leveraging green infrastructure as a form of climate change adaptation. Those involved in early work, myself included, suspected potential for wider services and co-benefits. Indeed, it was often noted in earlier times that urban greenery would only be widely supported if it could be shown to have many concurrent benefits. Proving that to be the case has kept a global community busy since. The more we discover, the more we refine the questions, the better the practical outcomes. As we look to the next steps, one thing we know for certain in 2020 is that trees and urban greenery bring many benefits to cities. Future proves past.

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