Integrated Urban Grey and Green Infrastructures

ANDREAS WESENER,[1] WENDY MCWILLIAM,[1]
SILVIA TAVARES[2] AND JANIS BIRKELAND[3]

Scope

This special issue, 'Integrated Urban Grey and Green Infrastructures', of *Landscape Review* contributes to the advancement of conceptual and scientific methodologies of grey and green integrative studies at multiple spatial scales. It addresses international research communities and practitioners in the fields of urban ecology, environmental planning, landscape architecture, urban design, architecture, geography, urban sociology and traffic engineering. The issue explores – through case studies – how infrastructure research and practice are being advanced in Australasian cities. The papers in this special issue were presented and discussed at the first Integrated Urban Grey + Green Infrastructure symposium held at the School of Landscape Architecture at Lincoln University, Canterbury, New Zealand, in November 2016. The symposium gathered experts from various disciplines to discuss advances in infrastructure design, planning and management in support of healthier and more resilient cities in the context of significant environmental events and changes. The symposium was convened by chairs Andreas Wesener, Wendy McWilliam and Silvia Tavares. Janis Birkeland – author of *Positive Development* (2008) and *Design for Sustainability* (2012) – was the invited keynote speaker.

Background

Grey infrastructure (eg, transport networks, including roads and cycleways, stormwater and sewage pipe systems) has long been recognised as providing a vital socioeconomic backbone for city development. Well-designed (public) open spaces, in particular, streets, pedestrian realms, squares and plazas, can make significant contributions to social inclusion (Sauter and Huettenmoser, 2008), community engagement (Hassen and Kaufman, 2016), neighbourhood vitality and diversity (Montgomery, 1998) and sense of place (Watson and Kessler, 2013). Green infrastructure (eg, parks, river corridors, street trees and urban forests, community gardens, green roofs and bio-filtration facilities) has also been recognised as playing an equally vital role, providing important ecosystem services in support of community health, wellbeing and social cohesion (de Vries et al, 2013). Services include food production (Barthel and Isendahl, 2013), microclimate stabilisation (Chiesura, 2004), air filtration (Nowak and Crane, 2006), carbon storage (Nowak and Crane, 2002), water cleansing and stormwater management (Keeley et al, 2013; Nickel et al, 2013), support for biodiversity (Fernández-Juricic, 2000), along with recreational amenity and aesthetic services (Wolch et al, 2014).

Andreas Wesener is Senior Lecturer in Urban Design at the School of Landscape Architecture, Faculty of Environment, Society and Design, PO Box 85084, Lincoln University, Lincoln 7647, Canterbury, New Zealand.
Telephone: +64–3–423–0460
Email: andreas.wesener@lincoln.ac.nz

GUEST EDITORIAL

Grey and green infrastructure functions have been viewed as competing in terms of both land use and access to government funding, and grey functions have been prioritised, resulting in the loss or degradation of green functions over time (Tjallingii, 2003). However, in cities vulnerable to extreme environmental events, such as earthquakes, and in the context of climate change and related phenomena, such as induced sea level rise, increased frequency and severity of storm events, heat waves and drought, the relative value of green infrastructure has increased (Gill et al, 2007). Recognition of the role green infrastructure can play in protecting cities from significant environmental events has led to a paradigm shift in urban planning and design toward more adaptive and integrated infrastructures (Hill, 2016), such as coastal protection systems (Sutton-Grier et al, 2015). Furthermore, scholars argue that integrated grey and green infrastructures have the potential to support higher, more efficient and cost-effective performance of both infrastructure types (Boyle et al, 2014), and could help decrease the negative effects associated with their fragmentation (Pauleit et al, 2017). Systemic change has been particularly apparent in the design of innovative stormwater management systems (eg, Wang et al, 2013; Page et al, 2015). However, additional prospective areas of application, including topics such as active modes of urban transport, recreation, social cohesion, flood retention and disaster mitigation, biodiversity, pollution control, and urban microclimates, could potentially improve the health and wellbeing of urban populations (Svendsen et al, 2012). Buildings are often not referred to as 'infrastructure'; however, treating buildings as separate entities seems counterproductive from a systems perspective. Integrated grey–green functions in the context of architecture and built structures are therefore additional relevant fields of research and application (Tiwary and Kumar, 2014).

Content

In the first contribution, Silvia Tavares and Simon Swaffield critically examine Christchurch's post-earthquake central city rebuild, focusing on the integration of compact city principles and green infrastructure and their influence on urban comfort. The authors argue that, while courtyards have been created, the quality of the public realm has been compromised in favour of private commercial development. Their analysis reveals that pre-earthquake efforts to establish best-practice urban design principles have only partly been adopted. Precinct-based planning schemes have led to highly controlled semi-private open spaces with restricted accessibility. Being disconnected from public open spaces, the new developments create only minimal public benefits related to urban comfort.

In the second paper, Josephine Neldner and Simon Kilbane broaden the discussion on infrastructure integration by arguing that landscape itself is infrastructural. The authors explore principles of landscape infrastructure and their application in undergraduate landscape architecture students' design projects in Sydney. Following in the conceptual wake of landscape urbanism, landscape infrastructure principles have evolved primarily in North America. By translating such concepts to the Australian context, the paper identifies generalisable principles and discusses how they could be applied.

Drawing on various examples, including the coastal wetlands in Auckland, the third contribution by Stephen Knight-Lenihan discusses opportunities to offset negative development impacts through the application of net positive environmental benefits. Among other factors, the net environmental benefit model relates to a stronger integration of grey and green infrastructure systems. Green–grey building components that integrate vegetation and micro-ecosystems, and new coastal or urban ecosystems that combine climate, biodiversity and recreational goals are examples of integrative systems discussed in the paper.

The next two papers bring us back to Christchurch. Bryan Jenkins discusses research-informed post-earthquake community-driven development proposals for the Avon–Ōtākaro River Corridor, also known as the 'residential red zone', combining environmental, economic, flood management and socio-cultural goals. One important research area is an assessment of the role of green infrastructure systems in replacing traditional grey infrastructure functions, including flood management, while simultaneously addressing the multiple challenges and opportunities of this vast area.

In the final contribution, Emilio Garcia presents a geographic information systems-based morphological analysis of Christchurch's central business district following the 2010/11 Canterbury earthquakes. The paper discusses changes in green and grey infrastructure with regard to size and diversity and in relation to a resilience framework. Based on three development scenarios, the author challenges compact city paradigms by arguing that Christchurch's post-earthquake urban landscape might be considered as an opportunity to increase the diversity of land uses and, concurrently, the resilience of the urban landscape.

Concluding remarks

The papers in this special issue demonstrate the importance of both grey and, in particular, green infrastructure, in support of community health and wellbeing. Their respective and integrative roles are illustrated in a range of case studies. They make a strong argument in support of repositioning green infrastructure with respect to grey infrastructure toward more sustainable and resilient urban communities. The variety of contributions shows that research on grey–green infrastructure systems has gained momentum in Australia and New Zealand. We hope this special issue of *Landscape Review* marks the beginning of a rich and evolving discussion that helps our cities to adapt to the many volatile and dynamic changes and challenges that are ahead of us.

NOTES

1 School of Landscape Architecture, Lincoln University, New Zealand.

2 College of Science and Engineering, James Cook University, Australia.

3 Faculty of Architecture, Building and Planning, University of Melbourne, Australia.

REFERENCES

Barthel, S and Isendahl, C (2013) Urban Gardens, Agriculture, and Water Management: Sources of Resilience for Long-Term Food Security in Cities, *Ecological Economics* 86, pp 224–234.

Birkeland, J (2008) *Positive Development: From Vicious Circles to Virtuous Cycles Through Built Environment Design*, London: Earthscan.

———(2012) *Design for Sustainability: A Sourcebook of Integrated Ecological Solutions*. London: Earthscan.

Boyle, C, Gamage, GB, Burns, B, Fassman-Beck, E, Knight-Lenihan, S, Schwendenmann, L and Thresher, W (2014) Greening Cities: A Review of Green Infrastructure, Auckland: University of Auckland.

Chiesura, A (2004) The Role of Urban Parks for the Sustainable City, *Landscape and Urban Planning* 68(1), pp 129–138. DOI: 10.1016/j.landurbplan.2003.08.003.

de Vries, S, van Dillen, SM, Groenewegen, PP and Spreeuwenberg, P (2013) Streetscape Greenery and Health: Stress, Social Cohesion and Physical Activity as Mediators, *Social Science & Medicine* 94, pp 26–33. DOI: 10.1016/j.socscimed.2013.06.030.

Fernández-Juricic, E (2000) Avifaunal Use of Wooded Streets in an Urban Landscape, *Conservation Biology* 14(2), pp 513–521. DOI: 10.1046/j.1523-1739.2000.98600.x.

Gill, SE, Handley, JF, Ennos, AR and Pauleit, S (2007) Adapting Cities for Climate Change: The Role of the Green Infrastructure, *Built Environment* 33(1), pp 115–133.

Hassen, N and Kaufman, P (2016) Examining the Role of Urban Street Design in Enhancing Community Engagement: A Literature Review, *Health & Place* 41, pp 119–132. DOI: 10.1016/j.healthplace.2016.08.005.

Hill, K (2016) Climate Change: Implications for the Assumptions, Goals and Methods of Urban Environmental Planning, *Urban Planning* 1(4), pp 103–113. DOI: 10.17645/up.v1i4.771.

Keeley, M, Koburger, A, Dolowitz, DP, Medearis, D, Nickel, D and Shuster, W (2013) Perspectives on the Use of Green Infrastructure for Stormwater Management in Cleveland and Milwaukee, *Environmental Management* 51(6), pp 1093–1108. DOI: 10.1007/s00267-013-0032-x.

Montgomery, J (1998) Making a City: Urbanity, Vitality and Urban Design, *Journal of Urban Design* 3(1), pp 93–116. DOI: 10.1080/13574809808724418.

Nickel, D, Schoenfelder, W, Medearis, D, Dolowitz, DP, Keeley, M and Shuster, W (2013) German Experience in Managing Stormwater with Green Infrastructure, *Journal of Environmental Planning and Management* 57(3), pp 403–423. DOI: 10.1080/09640568.2012.748652.

Nowak, DJ and Crane, DE (2002) Carbon Storage and Sequestration by Urban Trees in the USA, *Environmental Pollution* 116(2002), pp 381–389.

———and Stevens, JC (2006) Air Pollution Removal by Urban Trees and Shrubs in the United States, *Urban Forestry & Urban Greening* 4(3–4), pp 115–123. DOI: 10.1016/j.ufug.2006.01.007.

Page, JL, Winston, RJ, Mayes, DB, Perrin, C and Hunt, WF (2015) Retrofitting with Innovative Stormwater Control Measures: Hydrologic Mitigation of Impervious Cover in the Municipal Right-of-way, *Journal of Hydrology* 527, pp 923–932. DOI: 10.1016/j.jhydrol.2015.04.046.

Pauleit, S, Hansen, R, Rall, EL, Zölch, T, Andersson, E, Luz, AC et al (2017) Urban Landscapes and Green Infrastructure, *Oxford Research Encyclopedias*, Oxford: Oxford University Press.

Sauter, D and Huettenmoser, M (2008) Liveable Streets and Social Inclusion, *Urban Design International* 13(2), pp 67–79. DOI: 10.1057/udi.2008.15.

Sutton-Grier, AE, Wowk, K and Bamford, H (2015) Future of Our Coasts: The Potential for Natural and Hybrid Infrastructure to Enhance the Resilience of our Coastal Communities, Economies and Ecosystems, *Environmental Science & Policy* 51, pp 137–148. DOI: 10.1016/j.envsci.2015.04.006.

Svendsen, E, Northridge, ME and Metcalf, SS (2012) Integrating Grey and Green Infrastructure to Improve the Health and Well-being of Urban Populations, *Cities and Environment* 5(1).

Tiwary, A and Kumar, P (2014) Impact Evaluation of Green–Grey Infrastructure Interaction on Built-Space Integrity: An Emerging Perspective to Urban Ecosystem Service, *Science of The Total Environment* 487, pp 350–360. DOI: 10.1016/j.scitotenv.2014.03.032.

Tjallingii, S (2003) Green and Red: Enemies or Allies? The Utrecht Experience with Green Structure Planning, *Built Environment* 29(2), pp 107–116. DOI: 10.2148/benv.29.2.107.54466.

Wang, R, Eckelman, MJ and Zimmerman, JB (2013) Consequential Environmental and Economic Life Cycle Assessment of Green and Grey Stormwater Infrastructures for Combined Sewer Systems, *Environmental Science & Technology* 47(19), pp 11189–11198. DOI: 10.1021/es4026547.

Watson, GB and Kessler, L (2013) Small Changes – Big Gains: Transforming the Public and Communal Open Spaces in Rundown Neighbourhoods, *Journal of Urban Design* 18(4), pp 565–582. DOI: 10.1080/13574809.2013.824368.

Wolch, JR, Byrne, J and Newell, JP (2014) Urban Green Space, Public Health, and Environmental Justice: The Challenge of Making Cities 'Just Green Enough', *Landscape and Urban Planning* 125, pp 234–244. DOI: 10.1016/j.landurbplan.2014.01.017.