Cities 95 (2019) 102483

Contents lists available at ScienceDirect

Cities

journal homepage: www.elsevier.com/locate/cities

Building urban resilience with nature-based solutions: How can urban planning contribute?

Judy Bush[a,*], Andréanne Doyon[b]

[a] The University of Melbourne, Melbourne, VIC, 3010, Australia
[b] Simon Fraser University, 8888 University Drive, Burnaby, BC, Canada

ARTICLE INFO

Keywords:
Urban resilience
Nature-based solutions
Urban planning
Trade-offs
Ecosystem services
Transdisciplinarity

ABSTRACT

Cities face increasing environmental, social and economic challenges that together threaten the resilience of urban areas and the residents who live and work there. These challenges include chronic stresses and acute shocks, amplified by climate change impacts. Nature-based solutions have emerged as a concept for integrating ecosystem-based approaches to address a range of societal challenges. Nature-based solutions directly address and contribute to increased urban resilience. However, implementing nature-based solutions is inherently complex, given the range of ecosystem services, their multi-functionality and the trade-offs between functions, and across temporal and spatial scales. Urban planning can play a substantial role to support the implementation of nature-based solutions and to manage trade-offs and conflicts, as well as how social equity dimensions are considered. This paper presents a framework that guides the application of urban planning to nature-based solutions' implementation, by addressing key trade-offs across temporal, spatial, functional and social equity aspects. The framework highlights the key questions, and the supporting information required to address these questions, to underpin the inclusion of nature-based solutions for urban resilience. We find that while urban planning can contribute substantially, there are continuing gaps in how the inherently anthropocentric urban planning processes can give voice to non-human nature.

1. Introduction

Cities are facing increasing environmental, social and economic challenges that together threaten the resilience of urban areas and the residents who live and work there. These challenges include both chronic stresses and acute shocks. Climate change impacts are amplifying these challenges. Nature-based solutions have emerged as a concept for integrating a range of ecosystem-based approaches to address a range of societal challenges. Nature-based solutions directly address and contribute to increased urban resilience, but understandings of the mechanisms and vehicles for their implementation in cities are still being developed. There is potential for mainstreaming nature-based solutions through integration into urban planning approaches, but these are not yet well developed in either research or practice.

This conceptual paper demonstrates how nature-based solutions contribute to building urban resilience, and the roles required of urban planning in operationalising or implementing nature-based solutions. To do this, the paper reviews and brings together three bodies of literature to propose a framework for urban planning approaches to implementation of nature-based solutions. We first review the development of concepts of urban resilience and nature-based solutions and ecosystem services. We highlight the complexity of delivering nature-based solutions through the lens of ecosystem services, and nature-based solutions' multifunctionality. Our review highlights key gaps in nature-based solutions' conceptual framing, namely how social equity is addressed, and the range of trade-offs between functions and services and across time and space. Following this, we discuss the roles of urban (land-use) planning in the planning and management of cities, and how urban planning addresses trade-offs. We bring together the three bodies of literature to propose a framework for integrating nature-based solutions into urban planning, and demonstrate its application for strengthening urban resilience (Fig. 1).

2. Literature review

2.1. Urban resilience

The resilience of cities is dependent upon their ability to adjust and adapt in the face of change (Alberti & Marzluff, 2004; Alberti et al., 2003; Pickett, Cadenasso, & Grove, 2004). Resilience encompasses

* Corresponding author.
E-mail addresses: judy.bush@unimelb.edu.au (J. Bush), andreanne.doyon@sfu.ca (A. Doyon).

https://doi.org/10.1016/j.cities.2019.102483
Received 30 July 2019; Received in revised form 23 September 2019; Accepted 14 October 2019
Available online 24 October 2019

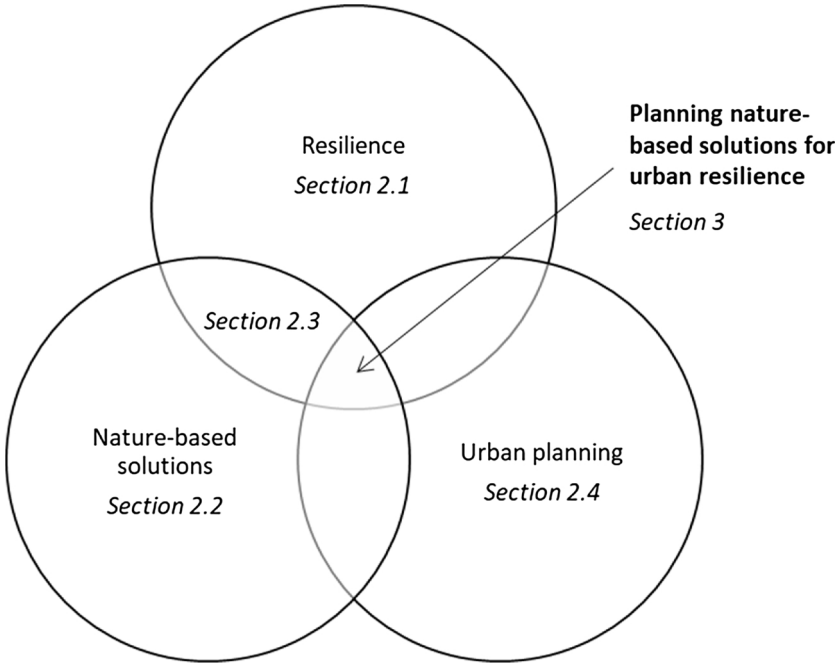

Fig. 1. Planning nature-based solutions for urban resilience: conceptual relationships.

responding to the gradual change and chronic stresses, often of socio-economic nature, and the abrupt change or acute shocks, often related to natural disasters (Resilient Melbourne, 2016). In this sense, 'resilience' is about more than recovering or rebuilding (Campanella, 2006; Elmqvist, Barnett, & Wilkinson, 2014). Resilience describes the ability of a system to "thrive during times of stability, and to adapt, organise and grow in response to change or disruption" (Gardner, 2019, p. 10). Urban resilience, according to Elmqvist et al. (2014) "is therefore about navigating a desirable system trajectory and state rather than avoiding abrupt change and collapse" (p. 22).

Resilience has become an important issue in urban policy (Davoudi et al., 2012). As 'resilience' has grown in influence, a wide range of international, national, metropolitan, and urban initiatives have been established (Wilkinson, 2011). Building urban resilience requires long-term, integrated approaches to urban planning and development (Antrobus, 2011), as well as a diverse range of disciplines, perspectives, and mechanisms, which bring together different approaches to explore viable transition pathways (Coaffee, 2013; Collier et al., 2013; Elmqvist et al., 2014; Meerow, Newell, & Stults, 2016). Recent literature around the operationalisation and implementation of urban resilience argues the need to reframe resilience, better understand the trade-offs, and link to issues of institutional embedding of new practices and policies (Chelleri, Waters, Olazabal, Minucci, & Urbanization, 2015; Coaffee et al., 2018). Furthermore, acknowledging the interlinkages between resilience and sustainability can better support desirable trajectories for urban transitions (Elmqvist et al., 2019).

Governance also needs to shift towards more anticipatory and proactive approaches (Coaffee et al., 2018), and connecting different actors and sectors in order to focus on "mainstreaming a resilience approach in all the city-level decision making" (Coaffee et al., 2018, p. 404). Studies show that despite the growing popularity of resilience, there is an implementation gap between resilience as an ambitious objective, and the capacity to govern resilience in practice at the urban level (Wagenaar & Wilkinson, 2015, p. 1265). Others have identified a gap in terms of the transformative potential of resilience initiatives, as many continue to reproduce the status quo, neglecting the implications for social justice and equity (Anguelovski, Connolly, & Brand, 2018; Fainstein, 2018). In reframing urban resilience, it is critical to focus on the politics of resilience, such as resilience from what, to what, and who gets to decide, as well as where, when, and why (Meerow & Newell, 2016; Meerow et al., 2016).

2.2. Nature-based solutions and ecosystem services

Ecological systems provide a wide range of functions which benefit humans and the cities in which they live. 'Nature-based solutions' has emerged as a concept, or umbrella term, for ecosystem-based approaches to address the societal challenges of climate change, natural disasters, food and water security, human health and well-being, and economic and social development (Cohen-Shacham, Walters, Janzen, & Maginnis, 2016; EC, 2015). Nature-based solutions address these societal challenges through the delivery of 'ecosystem services'. The MEA (2003) identified four categories of services: provisioning, regulating, cultural and supporting. Gómez-Baggethun et al. (2013) utilised the concept to highlight the provision of ecosystem services in urban areas that contribute to a city's resilience. The ecosystem services framework, in providing a simple, clear and useable typology, has been widely adopted in research literature (McDonough, Hutchinson, Moore, & Hutchinson, 2017), is being operationalised in policies, planning and practice (Ainscough et al., 2019; Jax et al., 2018), and acts a 'boundary object' to facilitate communication and collaboration between disciplines and sectors (Abson et al., 2014).

However, the concept is not without its criticisms. These revolve around the conceptualisation of ecosystem services being fundamentally anthropocentric and grounded in an economic approach that as a result excludes the intrinsic values of nature and non-human species, potentially leading to commodification of nature, and exploitative human-nature relationships (Schröter et al., 2014). While earlier applications of the term often focused on economic valuations of 'natural capital' (Costanza et al., 1997), considerable research since then has contributed to substantially more complex, holistic and inter-disciplinary understandings and applications (McDonough et al., 2017). The complexity of ecological processes that can span both services and 'disservices', sometimes simultaneously, has also been highlighted (Lyytimäki, 2015; Saunders & Luck, 2016). However, Saunders and Luck (2016) suggested that resorting to simplified dichotomies should be resisted, instead advocating for adoption of a "more nuanced, holistic approach" that addresses complexity and the temporal and spatial

Table 1
Nature-based solutions' contributions to enhancing urban resilience.

Urban resilience elements	Nature-based solutions (NBS) contributions
Climate change, crisis, and disaster response and management (Chelleri et al., 2015; Coaffee et al., 2018)	Ecosystem services contribute to mitigation of natural disasters and climate change, as well as adaptation to and recovery from disasters and crises, for both biophysical and social systems (Cohen-Shacham et al., 2016; Gómez-Baggethun et al., 2013)
Maintain or rapidly return to desired functions in the face of a disturbance; quickly transform systems that limit current or future adaptive capacity (Meerow et al., 2016)	Local provision of ecosystem services confers resilience; however, resilience of NBS may be constrained by lack of (bio)diversity, and lack of response diversity (management regimes) (McPhearson et al., 2015)
Address underlying risk factors and reduce exposure and vulnerability of people and assets to current and future threats (Coaffee et al., 2018)	NBS for decreasing vulnerability and enhancing resilience of cities to climate change (Brink et al., 2016; Kabisch et al., 2016)
Mutual interactions between social and ecological systems across multiple scales (Quigley, Blair, & Davison, 2018)	NBS can provide the location to create, strengthen, and reinforce a focus on complexity and interactions in social-ecological systems, which in turn supports governance and planning approaches to resilience (McPhearson et al., 2015)
Maintain function (insurance value) (McPhearson et al., 2015;Quigley et al., 2018)	Continued delivery of ecosystem services despite variability, disturbance and management uncertainty (McPhearson et al., 2015)
Maintain (bio)diversity (Biggs et al., 2012)	Nature takes many forms and functionsNBS maintain biological and cultural diversity and the ability of ecosystems to evolve over time (Cohen-Shacham et al., 2019; Dorst et al., 2019)
Flexibility (Biggs et al., 2012; McPhearson et al., 2015)	Alternative uses (synchronous, intra or inter temporal time scales); reversibility of decisions Can be implemented alone or in an integrated manner with other solutions to societal challenges (e.g., technological and engineering solutions) (Cohen-Shacham et al., 2019; Dorst et al., 2019; McPhearson et al., 2015)
Connected network (Biggs et al., 2012)	NBS applied at a landscape scale creates a connected network (Cohen-Shacham et al., 2019)
Localised approaches (Biggs et al., 2012)	Adaptation to place-based conditions; determined by site-specific natural and cultural contexts that include traditional, local and scientific knowledge (Cohen-Shacham et al., 2019; Dorst et al., 2019)
Social learning (Quigley et al., 2018)	NBS feedback to humans through monitoring delivery of ecosystem services (McPhearson et al., 2015)
Participation (Biggs et al., 2012)	Produce societal benefits in a fair and equitable way in a manner that promotes transparency and broad participation (Cohen-Shacham et al., 2019)

context of specific ecosystems. Others have raised questions in relation to how the concept addresses issues of the distribution of wealth, power, equity and access to urban ecosystems (for example Kull, Arnauld de Sartre, & Castro-Larrañaga, 2015). Addressing these dimensions, particularly in urban contexts, reinforces the roles for urban planning and governance in the implementation of ecosystem services and nature-based solutions, and in considering trade-offs and how they can be resolved or managed.

2.3. Relationship between urban resilience and nature-based solutions

Urban resilience is increased through the inclusion of nature-based solutions and their associated delivery of ecosystem services in urban areas (Table 1). Ecosystem services contribute to thriving cities during times of stability, particularly through the provision of cultural ecosystem services that bring social, cultural and community benefits and wellbeing. Nature-based solutions and urban green spaces provide the location for recreation, social interaction, building community cohesion and contributing to physical and mental health and wellbeing (Jennings & Bamkole, 2019). These services contribute to enhanced resilience to the chronic stresses and gradual changes to which cities are exposed. Increasingly, the contributions of ecosystems services are also being recognised as contributing to resilience to sudden change, disruptions and natural disasters (Cohen-Shacham et al., 2016). Ecosystems can buffer cities and enhance their resilience by mitigating the impacts of climate change, including heatwaves and storms (Kabisch et al., 2016). Compared with conventional, engineered adaptation measures that are often associated with "high costs, inflexibility and conflicting interests" (Brink et al., 2016, p. 111), nature-based solutions and "ecosystem-based adaptation" are potentially more resilient and cost-effective (Kabisch et al., 2016; Temmerman et al., 2013). Nature-based solutions effectively act as decentralised, distributed systems of infrastructure service provision, which are usually inherently more resilient than large, centralised grey infrastructure (Depietri & McPhearson, 2017).

Any discussion of the links between resilience and nature-based solutions should also be extended to encompass the resilience (or vulnerability) *of* ecosystems themselves. Climate change has major impacts on ecosystems (Li, Wu, Liu, Zhang, & Li, 2018). Ecosystem resilience focuses on maintaining the health and capacity for ecosystems to continue to function and provide ecosystem services (Xu, Marinova, & Guo, 2015), even in the face of both biophysical and 'societal challenges' highlighted previously. This requires dynamic urban systems that are adaptive to impacts of climate change as well as other environmental changes and impacts of urbanisation. The extent to which urban ecosystems, as isolated pockets of green space within the built environment, can themselves be resilient may be limited, but could be supported with active management, selection of temperature-adapted species, creation of connected networks and control of habitat disturbance and destruction processes (Garrard, Williams, Mata, Thomas, & Bekessy, 2017; Kendal et al., 2018; Parris et al., 2018).

We have shown how nature-based solutions have central roles in building and maintaining many aspects of urban resilience. However, there are key gaps in the framing of nature-based solutions, as well as in research on nature-based solutions for urban resilience, in the areas of equity and trade-offs. Brink et al. (2016), in a review of research on 'ecosystem-based adaptation', a concept closely aligned with 'nature-based solutions' (Dorst, van der Jagt, Raven, & Runhaar, 2019), found that few articles considered equity, and that the normative and ethical aspects require more attention. Furthermore, when nature-based solutions are planned and managed to primarily address single function priorities (such as heat mitigation, carbon sequestration or biodiversity habitat provision), there are trade-offs between priority functions and the multiple other functions and services (Mexia et al., 2018). Raymond et al. (2017) highlighted the multifunctionality of nature-based

solutions, but the lack of research or practical guidance that addresses this complexity.

Five key trade-offs have been identified across the urban resilience and the nature-based solutions literature. They are:

- Temporal
- Spatial
- Functional
- Social equity
- Species

Temporal trade-offs highlight that an approach used at one time can affect future opportunities (Chelleri et al., 2015). Spatial trade-offs exist primarily in two ways, cross-scale and between-scale. Cross-scale trade-offs are related to geography where plans or interventions in one location may impact another location. Between-scale trade-offs are related to capacity for resilience within communities or locations (Chelleri et al., 2015). Functional trade-offs are related to delivery of services in which prioritising one service may prevent or alter the delivery of another service (Mexia et al., 2018; Turkelboom et al., 2018). Social equity trade-offs refer to the uneven distribution of benefits and costs associated with provision of ecosystem services and proximity to nature-based solutions and urban green spaces (Kabisch et al., 2016). Species trade-offs emphasise that habitat and ecosystem management decisions and actions will favour some species and exclude others (Parris et al., 2018).

We argue that these trade-offs and gaps in conceptualisation and delivery of urban resilience and nature-based solutions reinforce the need to learn from and incorporate other disciplines. Urban planning has been identified as an approach to help address the trade-offs highlighted above (Turkelboom et al., 2018). Urban planning can both support nature-based solutions' implementation as well as provide tactics for addressing shortcomings to achieve urban resilience. The following section reviews the role of urban (land-use) planning and how it addresses trade-offs, particularly from the perspective of strategic and collaborative planning.

2.4. Urban planning

Urban planning is concerned with shaping cities, towns, and regions by managing development, infrastructure, and services. Urban planning, also known as land use, physical or spatial planning, is a spatial exercise to provide structure to activities through long-term thinking and decision making to guide future action (Wheeler, 2013). The practice of planning seeks to answer three fundamental questions: Where are we now? Where do we want to go? How do we get there? Urban planning is the intentional and explicit intervention in the built environment through the development of plans, programs and design. Rather than have cities progress indiscriminately, urban planners set a normative course to move towards a goal, that for many cities globally, is increasingly focused on achieving a more sustainable, resilient, compact, integrated, equal, and just future (Wheeler, 2013).

Urban living creates both benefits and risks for quality of life (Rydin et al., 2012), making urban planning inherently complex (creating 'wicked problems' as Rittel and Webber (1973) contended). There is always more than one objective for land use, including economic growth, fair distribution of income, social cohesion and stability, reduction of psychological stress, a healthy environment free from pollutants and hazards, a beautiful landscape and so on, and the processes are multidimensional (Albrechts, 2004). Planning is a continuous process of choosing strategically through time (Friend & Hickling, 2005); planners must clarify how an area could benefit from proposed change, and how it may be affected (Healey, 2009). Planning must be "selective and oriented to issues that really matter. As it is impossible to do everything that needs to be done, "strategic" implies that some decisions and actions are considered more important than others and that much of the process lies in making the tough decisions about what is most important for the purpose of producing fair, structural responses to problems, challenges, aspirations and diversity" (Albrechts, 2004, pp. 751–752).

Since the 1980s, collaborative planning has dominated urban planning discourse (Purcell, 2009) and "enjoys a privileged position in planning theory and practice" (Raynor, Doyon, & Beer, 2017, p. 217). Collaborative planning conceptualises an inclusive approach for expanding institutional capacity and helping local communities (Healey, 1998). It emerged alongside a growing interest in social democracy and justice, and an acknowledgement of deep inequalities of access to decision-making processes (Legacy, 2010; Schatz & Rogers, 2016), as well as the belief that technical and scientific advisors (i.e. planners) would benefit from the knowledge and experience of place of the communities they are serving (Corburn, 2003). Collaborative planning aims to address uneven power relations, and although it is difficult to conceptualise power imbalance, it involves being open to all interested parties and includes diverse and fluid discourse communities to co-learn and problem-solve to achieve stated desires (Healey, 1992; Innes & Booher, 2018). However, it is often criticised for emphasising process over defined goals and clear outcomes. In addition, the process itself is poorly suited to rapidly changing contexts (Davoudi & Strange, 2009).

In practice, planning is often focused on facilitating interdisciplinary information gathering and decision-making that navigates potentially conflicting views and priorities. Urban planning has therefore developed into a discipline that is well-placed to address the range of trade-offs associated with implementing nature-based solutions for urban resilience that we have identified in the previous section.

3. The role of urban planning nature-based solutions for urban resilience

In urban planning's engagement with resilience, new approaches to planning itself are evolving. Davoudi and Strange (2009) argued that by embracing a more resilient approach to planning, rather than an essentialist or positivist approach, planning can be more fluid, reflexive, dependent, connected, multifaceted, interpretive, and inclusive. Resilience approaches to urban planning also promote the integration of ecology with urban planning (Ahern, 2013; Davoudi et al., 2012). Resilience thinking can be integrated into planning in the evaluation of existing plans, programs, and planning measures to identify vulnerabilities and deficits. Resilience thinking can also help to identify vital issues within urban social-ecological systems in the decision-making stages of planning and urban design interventions (Eraydin & Taşan-Kok, 2013; Marcus & Colding, 2014). Resilience thinking stresses "the importance of assuming change and explaining stability, instead of assuming stability and explaining change" (Folke, Colding, & Berkes, 2003, p. 352). It offers a useful framework to help increase the capacity of adaptive responses in urban areas, and "the possibilities for transformation and change to a potentially better" system (Davoudi et al., 2012, p. 330). Planners cannot build resilience in isolation. They must form new relationships and partnerships with other policy domains within the city, as well as with climate scientists, developers, businesses and residents to create a more integrated urban management nexus (Coaffee, 2013; Elmqvist et al., 2014).

Planning has long recognized the importance of the green spaces for city dwellers (Buxton, Goodman, & Moloney, 2016; Hagan, 2014; Wheeler, 2013), but policies that incorporate nature-based solutions and ecosystem services are more recent additions to public policy suites (Jax et al., 2018). "Nature-based solutions offer exciting prospects and are being taken up around the world in urban planning to deliver multiple benefits and to reduce climate risk" (Frantzeskaki et al., 2019, p. 456). However, more practice-based evidence is needed to support mainstreaming these approaches, particularly within the contexts of trade-offs (Frantzeskaki et al., 2019). We know that urban planners must juggle a range of often competing demands and issues in the

planning and development of cities (Colding, 2011). When it comes to nature-based solutions, McPhearson, Andersson, Elmqvist and Frantzeskaki (2015) highlighted the need for planners and managers to go beyond simple understanding, towards better articulating the multiple values of urban ecosystem services for cities. Therefore, to integrate nature-based solutions for urban resilience, planners' new relationships and partnerships (Coaffee, 2013) need to extend to include urban ecologists, horticulturalists and landscape planners (Parris et al., 2018; Scott et al., 2016).

3.1. Framework: planning for nature-based solutions

The previous sections have shown how nature-based solutions can support and underpin increased resilience of cities and urban areas, but gaps were identified with nature-based solutions' coverage of social equity dimensions. In addition, both the fields of urban resilience and nature-based solutions are weak in terms of practical efforts and solutions to address trade-offs. We have shown how planning addresses this range of trade-offs and potential conflicts. We contend therefore that planning can play a critical role in operationalising or implementing nature-based solutions to contribute to urban resilience and increasing social equity.

Furthermore, we have shown how both resilience and nature-based solutions concepts have themselves influenced approaches to urban planning. Resilience thinking has reinforced an urban planning focus on adaptation and change; and nature-based solutions have supported an increasingly sophisticated understanding in urban planning of the delivery of a range of urban ecosystem services. However, the integration of resilience and nature-based solutions is far from 'mainstream' in urban planning. In addition, the role of urban planning in nature-based solutions' implementation is not well recognised in either research or practice. To address these gaps, we propose a framework to guide and support the implementation of nature-based solutions and their integration into urban planning for urban resilience. The framework (Table 2) defines how planning addresses the dimensions of trade-offs. As noted previously, planning in practice is often focused on facilitation of interdisciplinary input and decision making. Therefore, this framework is presented as a set of guiding questions and associated information needs, that explicitly address the trade-offs, to support and prompt these facilitation efforts. In the following section we demonstrate its application using examples related to nature-based solutions for mitigating sea level rise and other urban planning challenges.

3.2. Addressing trade-offs: applying the framework

Enhancing resilience in one system may have negative consequences in another, and this can include systems across time. When addressing *temporal trade-offs* and considering short- and long-term outcomes associated with the inclusion or exclusion of nature-based solutions, considerations should go beyond simply ensuring that short-term land uses do not preclude longer term installation of nature-based solutions. For example, planning for sea-level rise involves a focus on long term projections as well as short term (interim) land uses. Planning processes attempt to incorporate a focus on multiple temporal scales, spanning the short-, medium and long-term. Given nature-based solutions grow, develop, evolve and change over time (as dynamic living systems), planning for nature-based solutions can reinforce and embody this temporal multi-scalar process. Planning for nature-based solutions requires a heightened focus on how the form, structure and function of nature-based solutions change over time.

Spatial trade-offs are manifested in two ways: cross-scale and between scale. From a cross-scale perspective, the loss of coastal wetlands, sea-level rise and the hard surfaces of the built environment have led to increased flood risks in many regions, with flood protection structures such as sea walls exacerbating flood risks in adjacent, unprotected areas (Temmerman et al., 2013). Spatial biophysical and ecological data are needed to determine potential impacts of nature-based solutions to address these problems, while not creating larger problems somewhere else. Planning can provide a wider perspective that crosses land ownership boundaries so that land use decisions explicitly consider spatial trade-offs. However, where jurisdictional boundaries and biophysical boundaries are inconsistent, trade-offs or jurisdictional conflicts may persist, requiring co-management or multi-level governance approaches (Cash et al., 2006).

Table 2
Planning nature-based solutions for urban resilience: addressing trade-offs.

Dimensions	Urban planning characteristics	Applying urban planning to NBS: questions to ask	Applying urban planning to NBS: Information required
Temporal	Differentiates short and long-term actions (Albrechts et al., 2017) A continuous process (Friend & Hickling, 2005)	Can one approach open or close the window of opportunity for future development? (Chelleri et al., 2015)	Short-term and long-term outcomes associated with inclusion or exclusion of NBS.Knowledge of how the form, structure and functions of NBS change and evolve over time.
Spatial	Operates at multiple spatial scales (Healey, 2009) Place-based approaches (Healey, 2009; Turkelboom et al., 2018)	Does action in one location negatively/positively affect another location?How equal is the distribution of capacities for resilience? (Chelleri et al., 2015)	Fine-grained spatial socio-economic, demographic, jurisdictional, biophysical and ecological data.
Functional	Decision making processes with clear goals and priorities; balancing multiple interests and preferences (Albrechts, 2004; Kaza, 2006) Creates a structure and set of rules for changes in land use (Albrechts et al., 2017; Turkelboom et al., 2018)	Will prioritising delivery of specific ecosystem services reduce or prevent delivery of other ecosystem services? (Mexia et al., 2018) How does changing the land-use (or objective of land-use) alter the ecosystem services? (Turkelboom et al., 2018)	Knowledge and understanding of biophysical delivery mechanisms of ecosystem services.
Social equity	Provides a process for acknowledging (and accepting) conflict, clashes, collaboration, coordination, co-production (Albrechts et al., 2017) Identifies all potential stakeholders; establish different ways to participate; create opportunities for open dialogue; develop shared understanding (Healey, 1992; Innes & Booher, 2018) Incorporates different forms of knowledge, community ideas, opinions and experiences (Corburn, 2003)	How are the functions and benefits of the nature-based solutions and ecosystem services distributed across the urban area?Who (and what) is welcomed or excluded?How does the distribution, design and management contribute to this welcome or exclusion?(Kabisch et al., 2016)	Fine-grained spatial socio-economic, cultural and demographic data
Species diversity	Provides a process for acknowledging (and accepting) conflict, clashes, collaboration, coordination, co-production (Albrechts et al., 2017) though largely applied anthropocentrically.	Which species are favoured and which species are excluded in the design and management of the nature-based solutions, biodiversity habitat and land use planning?(Parris et al., 2018)	Knowledge of species assemblages within ecosystems and of habitat preferences and requirements across species lifecycles.

Functional trade-offs may occur in responding to urban strategic priorities, where delivery of one or several specific ecosystem services may be prioritised over other services. For example, prioritising coastal landscapes that support recreation, such as dog walking, may affect habitat quality and breeding behaviour of coastal biodiversity (Parris, 2016) or reduce the area of coastal wetlands and mangroves that can more effectively mitigate impacts of sea level rise and storm surges. In urban areas impacted by heatwaves, vegetation may be planned to primarily deliver cooling benefit. Well-watered trees with dense canopies provide the most effective cooling functions (Duncan et al., 2019), but may reduce the quality of biodiversity habitat provision, particularly if non-local species of trees are selected (Threlfall et al., 2017). In addressing *functional trade-offs*, urban planning contributes through making explicit the range of strategic urban goals and priorities, by defining consultation processes and by creating clear rules and processes for land use decision-making.

Urban planning is well-equipped to address or mitigate *social equity trade-offs* associated with the implementation of nature-based solutions, through the application of processes for stakeholder engagement, participatory decision-making and inclusion of different forms of knowledge and different types of data. Increasing the granularity of data (towards more fine-grained data) supports more informed and proactive decisions. For example, spatial socio-economic and demographic data collected after Hurricane Katrina showed that about 46% of damaged areas were home to African Americans and that approximately 20% of damaged households were living below the poverty line, indicating high vulnerability and low capacity. In response to this, the City of New Orleans has emphasised equity in its resilience strategy, stating, “By investing in equity, we are investing in resilience. Equity will be the driving force behind our economy’s growth and innovation, our communities’ safety and stability, and our families’ health and prosperity” (City of New Orleans, 2015, p. 52). For environmental justice considerations, ensuring the equitable distribution of environmental benefits associated with proximity to urban green spaces and nature-based solutions is particularly important. With the increasing research findings of the benefits of exposure to green space for mental and physical health and well-being, social cohesion and community liveability (cultural ecosystem services), the role of urban planning in ensuring social equity across and within cities is vital (Bush & Doyon, 2017).

Finally, similar to functional trade-offs, *species trade-offs* may occur where the decisions to foster, encourage or plant some species or ecotypes will preclude other species. Examples include establishing or maintaining particular water levels or inundation regimes in coastal wetlands, that will selectively preference some species (flora and fauna) over others (Barnagaud et al., 2019). Other examples include planting nectar-producing shrubs to attract particular species of birds or butterflies, but their presence may dissuade other species, or smaller less aggressive species from using these areas (Parris, 2016; Parris et al., 2018). To manage species trade-offs requires active collaboration between urban ecologists and planners. Planning’s roles again focus on clearly defining key land use priorities and objectives, and facilitating cross-disciplinary collaboration and knowledge sharing.

4. Discussion

In this section we briefly discuss the strengths and weaknesses of the framework and its application. While planning can strengthen and reinforce the integration of nature-based solutions into urban development processes, there are continuing challenges with availability and application of data to support this. We have shown how planning has the potential to contribute to more effective and comprehensive implementation of nature-based solutions, by providing the mechanisms and processes for addressing the trade-offs between multiple functions and services. Planning provides explicit and informed prioritisation processes that acknowledge that trade-offs are unavoidable, and therefore need to be planned and managed. Planning can provide the processes for defining the overarching goals and objectives against which urban designs and developments must perform. In doing so, planning can furnish the means for deciding between competing demands embedded within complexity, multifunctionality and trade-offs.

In addition, planning has the potential to support a pro-active focus on inclusion of nature-based solutions in cities. Through its regulatory approach to defining and specifying land use, allocation of space and function, planning provides a formalised, recognised and authoritative mechanism. As such, planning provisions and regulations that address or include nature-based solutions have the capacity to support their increased adoption or ‘mainstreaming’ into urban development processes and projects (Phelan, Hurley, & Bush, 2018).

The *Planning for nature-based solutions* framework (Table 2) identifies the key information needed to support its implementation. However, a critical challenge persists in the availability and accessibility of the necessary data. The necessary data may not be collected at all, it may be collected inconsistently or incompletely at different time points, or across different spatial scales. The data may lack the spatial granularity to enable relevant and appropriate local application, or to support local decision-making between conflicting needs or functions. Meerow and Newell (2016) showed how in addressing priority ecosystem functions, different spatial scale data could lead to different spatial outcomes for location of urban green spaces.

Furthermore, in providing the evidence-base to support decision-making processes, some local elected officials specify only locally generated research and data as being relevant or accepted (rather than data or research findings that have been generated from other areas of the same city, or from other cities or countries), and this highly parochial approach can limit data deemed acceptable or relevant (Bush, 2017). Compounding this, monitoring and evaluation of projects by policy makers and land managers is often not well-resourced. As a result, monitoring data may not be collected, or there may be a reliance on ad hoc collection of citizen-science generated data (Bush, 2017).

Even with the availability of accurate and comprehensive data, there may still be challenges associated with understanding and interpreting the data, particularly data related to biodiversity and ecological systems and functions. This reinforces the necessity for transdisciplinary collaborations between planners and built environment disciplines with ecologists and environmental scientists in planning and implementing nature-based solutions (Parris et al., 2018).

Finally, we have presented a range of examples to illustrate the different types of trade-offs and the roles of planning in addressing each of these trade-offs. We have selected examples that are related to sea level rise to demonstrate how multiple trade-offs may arise and need to be considered simultaneously. However, in practice, multiple conflicts and trade-offs may interact to exacerbate and complicate both problem identification and selection of solutions. The complexity inherent in urban systems reinforces the importance of sophisticated urban planning responses that can support and facilitate effective and equitable decision-making and ongoing management.

5. Conclusion

This paper demonstrates how nature-based solutions contribute to building urban resilience, and the roles required of urban planning in operationalising or implementing nature-based solutions. Resilience offers urban planning the opportunity to question its approach, and develop a more transformational and radical agenda, one that opens opportunities to challenge accepted ways of thinking (Davoudi et al., 2012). Likewise, urban planning provides the mechanisms through which nature-based solutions can be more effectively and comprehensively implemented in urban areas. Urban planning contributes the processes and mechanisms for the identification of strategic aims and objectives, participatory approaches to knowledge and data collection, and decision-making processes for land uses. If these urban planning

processes are applied to the planning and implementation of nature-based solutions, they can potentially support and encourage increased implementation. In addition, if nature-based solutions are integrated into land-use planning provisions and regulations, this too may encourage increased implementation.

There are however key gaps and omissions in existing urban planning processes for nature-based solutions that will need to be addressed and developed if planning is to comprehensively support their implementation. Urban planning is largely anthropocentric; cities need to be recognised as shared habitats. For urban planning to effectively support nature-based solutions' implementation, new and evolving practices of research using multi-species approaches are needed. New processes are required for the inclusion and representation of the non-human elements of our cities in planning processes. With the development of the planning for nature-based solutions framework, our goal is to contribute to this emerging multidisciplinary field.

Funding

This work was supported by the Australian Government's National Environmental Science Program through the Clean Air and Urban Landscapes Hub.

References

Abson, D. J., von Wehrden, H., Baumgärtner, S., Fischer, J., Hanspach, J., Härdtle, W., & Walmsley, D. (2014). Ecosystem services as a boundary object for sustainability. *Ecological Economics, 103*, 29–37. https://doi.org/10.1016/j.ecolecon.2014.04.012.

Ahern, J. (2013). Urban landscape sustainability and resilience: The promise and challenges of integrating ecology with urban planning and design. *Landscape Ecology, 28*(6), 1203–1212. https://doi.org/10.1007/s10980-012-9799-z.

Ainscough, J., de Vries Lentsch, A., Metzger, M., Rounsevell, M., Schröter, M., Delbaere, B., & Staes, J. (2019). Navigating pluralism: Understanding perceptions of the ecosystem services concept. *Ecosystem Services, 36*. https://doi.org/10.1016/j.ecoser.2019.01.004.

Alberti, M., & Marzluff, J. M. (2004). Ecological resilience in urban ecosystems: Linking urban patterns to human and ecological functions. *Urban Ecosystems, 7*(3), 241–265. https://doi.org/10.1023/B:UECO.0000044038.90173.c6.

Alberti, M., Marzluff, J. M., Shulenberger, E., Bradley, G., Ryan, C., & Zumbrunnen, C. (2003). Integrating humans into ecology: Opportunities and challenges for studying urban ecosystems. *BioScience, 53*(12), 1169–1179. https://doi.org/10.1641/0006-3568(2003)053[1169:IHIEOA]2.0.CO;2.

Albrechts, L. (2004). Strategic (spatial) planning reexamined. *Environment and Planning B, Planning & Design, 31*(5), 743–758. https://doi.org/10.1068/b3065.

Albrechts, L. (2017). Some ontological and epistemological challenges. In L. Albrechts, A. Balducci, & J. Hillier (Eds.). *Situated practices of strategic planning: An international perspective* (pp. 1–12). London, UK: Routledge.

Anguelovski, I., Connolly, J., & Brand, A. L. (2018). From landscapes of utopia to the margins of the green urban life: for whom is the new green city? *City, 22*(3), 417–436. https://doi.org/10.1080/13604813.2018.1473126.

Antrobus, D. (2011). Smart green cities: from modernization to resilience? *Urban Research & Practice, 4*(2), 207–214.

Barnagaud, J. Y., Papaïx, J., Audevard, A., Lascève, M., Wroza, S., & Geoffroy, D. (2019). Interspecific variations in shorebird responses to management practices on protected Mediterranean saltpans. *Biological Conservation, 237*, 470–479. https://doi.org/10.1016/j.biocon.2019.07.035.

Biggs, R., Schlüter, M., Biggs, D., Bohensky, E. L., BurnSilver, S., Cundill, G., & West, P. C. (2012). Toward principles for enhancing the resilience of ecosystem services. *Annual Review of Environment and Resources, 37*(1), 421–448. https://doi.org/10.1146/annurev-environ-051211-123836.

Brink, E., Aalders, T., Ádám, D., Feller, R., Henselek, Y., Hoffmann, A., & Wamsler, C. (2016). Cascades of green: A review of ecosystem-based adaptation in urban areas. *Global Environmental Change Part A, 36*, 111–123. https://doi.org/10.1016/j.gloenvcha.2015.11.003.

Bush, J. (2017). *Cooling cities with green space: Policy perspectives*PhD Thesis. Melbourne: The University of Melbourne.

Bush, J., & Doyon, A. (2017). Urban green spaces in Australian cities: Social inclusion and community participation. *State of Australian Cities Conference*.

Buxton, M., Goodman, R., & Moloney, S. (2016). *Planning Melbourne: Lessons for a sustainable city*. Clayton, Vic: CSIRO Publishing.

Campanella, T. J. (2006). Urban resilience and the recovery of New Orleans. *Journal of the American Planning Association, 72*(2), 141–146. https://doi.org/10.1080/01944360608976734.

Cash, D., Adger, W. N., Berkes, F., Garden, P., Lebel, L., Olsson, P., & Young, O. (2006). Scale and cross-scale dynamics: Governance and information in a multilevel world. *Ecology and Society, 11*(2).

Chelleri, L., Waters, J. J., Olazabal, M., Minucci, G. J. E., & Urbanization (2015). Resilience trade-offs: Addressing multiple scales and temporal aspects of urban resilience. *Environment and Urbanization, 27*(1), 181–198.

City of New Orleans (2015). *Resilient New Orleans. Strategic actions to shape our future city*. New Orleans, Louisiana: City of New Orleans Retrieved fromhttp://resilientnola.org/wp-content/uploads/2015/08/Resilient_New_Orleans_Strategy.pdf.

Coaffee, J. (2013). Towards next-generation urban resilience in planning practice: From securitization to integrated place making. *Planning Practice and Research, 28*(3), 323–339. https://doi.org/10.1080/02697459.2013.787693.

Coaffee, J., Therrien, M. C., Chelleri, L., Henstra, D., Aldrich, D. P., Mitchell, C. L., & Rigaud, É. (2018). Urban resilience implementation: A policy challenge and research agenda for the 21st century. *Journal of Contingencies and Crisis Management, 26*(3), 403–410. https://doi.org/10.1111/1468-5973.12233.

Cohen-Shacham, E., Andrade, A., Dalton, J., Dudley, N., Jones, M., Kumar, C., & Walters, G. (2019). Core principles for successfully implementing and upscaling nature-based solutions. *Environmental Science & Policy, 98*, 20–29. https://doi.org/10.1016/j.envsci.2019.04.014.

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (2016). *Nature-based solutions to address global societal challenges*. Gland, Switzerland.

Colding, J. (2011). The role of ecosystem services in contemporary urban planning. In J. Niemelä, J. H. Breuste, & G. Guntenspergen (Eds.). *Urban ecology: Patterns, processes, and applications* (pp. 228–237). Oxford: Oxford University Press.

Collier, M. J., Nedović-Budić, Z., Aerts, J., Connop, S., Foley, D., Foley, K., & Verburg, P. (2013). Transitioning to resilience and sustainability in urban communities. *Cities, 32*, S21–S28. https://doi.org/10.1016/j.cities.2013.03.010.

Corburn, J. (2003). Bringing local knowledge into environmental decision making: Improving urban planning for communities at risk. *Journal of Planning Education and Research, 22*(4), 420–433. https://doi.org/10.1177/0739456X03022004008.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature, 387*(6630), 253–260. https://doi.org/10.1038/387253a0.

Davoudi, S., Shaw, K., Haider, L. J., Quinlan, A. E., Peterson, G. D., Wilkinson, C., & Porter, L. (2012). Resilience: A bridging concept or a dead end? "reframing" resilience: Challenges for planning theory and practice Interacting traps: Resilience assessment of a pasture management system in Northern Afghanistan Urban resilience: What does it mean in planning practice? Resilience as a useful concept for climate change adaptation? the politics of resilience for planning: A cautionary note. *Planning Theory & Practice, 13*(2), 299–333. https://doi.org/10.1080/14649357.2012.677124.

Davoudi, S., & Strange, I. (2009). *Conceptions of space and place in strategic spatial planning*. New York: Routledge.

Depietri, Y., & McPhearson, T. (2017). Integrating the grey, green, and blue in cities: Nature-based solutions for climate change adaptation and risk reduction. In N. Kabisch, H. Korn, J. Stadler, & A. Bonn (Eds.). *Nature-based solutions to climate change adaptation in urban areas: Linkages between science, policy and practice* (pp. 91–109). Cham: Springer International Publishing.

Dorst, H., van der Jagt, A., Raven, R., & Runhaar, H. (2019). Urban greening through nature-based solutions – Key characteristics of an emerging concept. *Sustainable Cities and Society, 49*, 101620. https://doi.org/10.1016/j.scs.2019.101620.

Duncan, J. M. A., Boruff, B., Saunders, A., Sun, Q., Hurley, J., & Amati, M. (2019). Turning down the heat: An enhanced understanding of the relationship between urban vegetation and surface temperature at the city scale. *The Science of the Total Environment, 656*, 118–128. https://doi.org/10.1016/j.scitotenv.2018.11.223.

EC (2015). *Nature-based solutions and re-naturing cities. Final report of the Horizon 2020 Expert Group*Retrieved from. Brussels: Directorate-General for Research and Innovation, European Commissionhttp://bookshop.europa.eu/en/towards-an-eu-research-and-innovation-policy-agenda-for-nature-based-solutions-re-naturing-cities-pbKI0215162/.

Elmqvist, T., Andersson, E., Frantzeskaki, N., McPhearson, T., Olsson, P., Gaffney, O., & Folke, C. (2019). Sustainability and resilience for transformation in the urban century. *Nature Sustainability, 2*(4), 267–273. https://doi.org/10.1038/s41893-019-0250-1.

Elmqvist, T., Barnett, G., & Wilkinson, C. (2014). Exploring urban sustainability and resilience. In L. Pearson, P. Newton, & P. Roberts (Eds.). *Resilient sustainable cities: A future* (pp. 19–29). Abingdon: Routledge.

Eraydin, A., & Taşan-Kok, T. (Eds.). (2013). *Resilience thinking in urban planning*. Dordrecht: Springer.

Fainstein, S. S. (2018). Resilience and justice: Planning for New York City. *Urban Geography, 39*(8), 1268–1275. https://doi.org/10.1080/02723638.2018.1448571.

Folke, C., Colding, J., & Berkes, F. (2003). Synthesis: Building resilience and adaptive capacity in social-ecological systems. In F. Berkes, J. Colding, & C. Folke (Eds.). *Navigating social-ecological systems: Building resilience for complexity and change* (pp. 352–387). Cambridge: Cambridge University Press.

Frantzeskaki, N., McPhearson, T., Collier, M. J., Kendal, D., Bulkeley, H., Dumitru, A., & Pintér, L. (2019). Nature-based solutions for urban climate change adaptation: Linking science, policy, and practice communities for evidence-based decision-making. *BioScience*. https://doi.org/10.1093/biosci/biz042.

Friend, J. K., & Hickling, A. (2005). *Planning under pressure: The strategic choice approach* (3rd ed.). Amsterdam: Elsevier/Butterworth Heinemann.

Gardner, J. (2019). The inclusive healthy places framework: A new tool for social resilience and public infrastructure. *Biophilic Cities Journal, 2*(2), 10–15.

Garrard, G. E., Williams, N. S. G., Mata, L., Thomas, J., & Bekessy, S. A. (2017). Biodiversity sensitive urban design. *Conservation Letters, 11*(2), e12411. https://doi.org/10.1111/conl.12411.

Gómez-Baggethun, E., Gren, Å., Barton, D. N., Langemeyer, J., McPhearson, T., O'Farrell, P., & Kremer, P. (2013). Urban ecosystem services. In T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P. J. Marcotullio, R. I. McDonald, & C. Wilkinson (Eds.). *Urbanization, biodiversity and ecosystem services: Challenges and opportunities. A global assessment* (pp. 175–251). Dordrecht: Springer.

Hagan, S. (2014). *Ecological urbanism: The nature of the city.* Hoboken: Taylor and Francis.
Healey, P. (1992). A planner's day: Knowledge and action in communicative practice. *Journal of the American Planning Association, 58*(1), 9–20. https://doi.org/10.1080/01944369208975531.
Healey, P. (1998). Building institutional capacity through collaborative approaches to urban planning. *Environment & Planning A, 30*(9), 1531–1546. https://doi.org/10.1068/a301531.
Healey, P. (2009). In search of the "strategic" in spatial strategy making. *Planning Theory & Practice, 10*(4), 439–457. https://doi.org/10.1080/14649350903417191.
Innes, J. E., & Booher, D. E. (2018). *Planning with complexity* (2nd ed.). London: Routledge.
Jax, K., Furman, E., Saarikoski, H., Barton, D. N., Delbaere, B., Dick, J., & Watt, A. D. (2018). Handling a messy world: Lessons learned when trying to make the ecosystem services concept operational. *Ecosystem Services, 29*, 415–427. https://doi.org/10.1016/j.ecoser.2017.08.001.
Jennings, V., & Bamkole, O. (2019). The relationship between social cohesion and urban green space: An avenue for health promotion. *International Journal of Environmental Research and Public Health, 16*(3), https://doi.org/10.3390/ijerph16030452.
Kabisch, N., Frantzeskaki, N., Pauleit, S., Naumann, S., Davis, M., Artmann, M., & Bonn, A. (2016). Nature-based solutions to climate change mitigation and adaptation in urban areas: Perspectives on indicators, knowledge gaps, barriers, and opportunities for action. *Ecology and Society, 21*(2), 39. https://doi.org/10.5751/ES-08373-210239.
Kaza, N. (2006). Tyranny of the median and costly consent: A reflection on the justification for participatory urban planning processes. *Planning Theory, 5*(3), 255–270. https://doi.org/10.1177/1473095206068630.
Kendal, D., Dobbs, C., Gallagher, R. V., Beaumont, L. J., Baumann, J., Williams, N. S. G., & Livesley, S. J. (2018). A global comparison of the climatic niches of urban and native tree populations. *Global Ecology and Biogeography*. https://doi.org/10.1111/geb.12728 n/a-n/a.
Kull, C. A., Arnauld de Sartre, X., & Castro-Larrañaga, M. (2015). The political ecology of ecosystem services. *Geoforum, 61*, 122–134. https://doi.org/10.1016/j.geoforum.2015.03.004.
Legacy, C. (2010). Investigating the knowledge interface between stakeholder engagement and plan-making. *Environment & Planning A, 42*(11), 2705–2720. https://doi.org/10.1068/a43164.
Li, D., Wu, S., Liu, L., Zhang, Y., & Li, S. (2018). Vulnerability of the global terrestrial ecosystems to climate change. *Global Change Biology, 24*(9), 4095–4106. https://doi.org/10.1111/gcb.14327.
Lyytimäki, J. (2015). Ecosystem disservices: Embrace the catchword. *Ecosystem Services, 12*, 136. https://doi.org/10.1016/j.ecoser.2014.11.008.
Marcus, L., & Colding, J. (2014). Toward an integrated theory of spatial morphology and resilient urban systems. *Ecology and Society, 19*(4), https://doi.org/10.5751/ES-06939-190455.
McDonough, K., Hutchinson, S., Moore, T., & Hutchinson, J. M. S. (2017). Analysis of publication trends in ecosystem services research. *Ecosystem Services, 25*, 82–88. https://doi.org/10.1016/j.ecoser.2017.03.022.
McPhearson, T., Andersson, E., Elmqvist, T., & Frantzeskaki, N. (2015). Resilience of and through urban ecosystem services. *Ecosystem Services, 12*, 152–156. https://doi.org/10.1016/j.ecoser.2014.07.012.
MEA (2003). *Ecosystems and human well-being: A framework for assessment. Millennium ecosystem assessment.* Washington, DC: Island Press.
Meerow, S., & Newell, J. P. (2016). Urban resilience for whom, what, when, where, and why? *Urban Geography,* 1–21. https://doi.org/10.1080/02723638.2016.1206395.
Meerow, S., Newell, J. P., & Stults, M. (2016). Defining urban resilience: A review. *Landscape and Urban Planning, 147*, 38–49. https://doi.org/10.1016/j.landurbplan.2015.11.011.
Mexia, T., Vieira, J., Príncipe, A., Anjos, A., Silva, P., Lopes, N., & Pinho, P. (2018). Ecosystem services: Urban parks under a magnifying glass. *Environmental Research, 160*, 469–478. https://doi.org/10.1016/j.envres.2017.10.023.
Parris, K. M. (2016). *Ecology of urban environments.* Hoboken, UK: John Wiley & Sons.
Parris, K. M., Amati, M., Bekessy, S. A., Dagenais, D., Fryd, O., Hahs, A. K., & Williams, N. S. G. (2018). The seven lamps of planning for biodiversity in the city. *Cities, 83*, 44–53. https://doi.org/10.1016/j.cities.2018.06.007.
Phelan, K., Hurley, J., & Bush, J. (2018). Land-use planning's role in urban forest strategies: Recent local government approaches in Australia. *Urban Policy and Research, 37*(2), 215–226. https://doi.org/10.1080/08111146.2018.1518813.
Pickett, S. T. A., Cadenasso, M. L., & Grove, J. M. (2004). Resilient cities: Meaning, models, and metaphor for integrating the ecological, socio-economic, and planning realms. *Landscape and Urban Planning, 69*(4), 369–384. https://doi.org/10.1016/j.landurbplan.2003.10.035.
Purcell, M. (2009). Resisting neoliberalization: communicative planning or counter-hegemonic movements? *Planning Theory, 8*(2), 140–165. https://doi.org/10.1177/1473095209102232.
Quigley, M., Blair, N., & Davison, K. (2018). Articulating a social-ecological resilience agenda for urban design. *Journal of Urban Design, 23*(4), 581–602. https://doi.org/10.1080/13574809.2018.1440176.
Raymond, C. M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Nita, M. R., & Calfapietra, C. (2017). A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science & Policy, 77*, 15–24. https://doi.org/10.1016/j.envsci.2017.07.008.
Raynor, K. E., Doyon, A., & Beer, T. (2017). Collaborative planning, transitions management and design thinking: Evaluating three participatory approaches to urban planning. *Australian Planner, 54*(4), 215–224. https://doi.org/10.1080/07293682.2018.1477812.
Resilient Melbourne (2016). *Resilient Melbourne: Resilience strategy for greater Melbourne.* Melbourne: City of Melbourne.
Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*(2), 155–169. https://doi.org/10.2307/4531523.
Rydin, Y., Bleahu, A., Davies, M., Dávila, J. D., Friel, S., De Grandis, G., & Wilson, J. (2012). Shaping cities for health: Complexity and the planning of urban environments in the 21st century. *Lancet, 379*(9831), 2079–2108. https://doi.org/10.1016/S0140-6736(12)60435-8.
Saunders, M. E., & Luck, G. W. (2016). Limitations of the ecosystem services versus disservices dichotomy. *Conservation Biology, 30*(6), 1363–1365. https://doi.org/10.1111/cobi.12740.
Schatz, L., & Rogers, D. (2016). Participatory, technocratic and neoliberal planning: An untenable planning governance ménage à trois. *Australian Planner, 53*(1), 37–45. https://doi.org/10.1080/07293682.2015.1135816.
Schröter, M., van der Zanden, E. H., van Oudenhoven, A. P. E., Remme, R. P., Serna-Chavez, H. M., de Groot, R. S., & Opdam, P. (2014). Ecosystem services as a contested concept: A synthesis of critique and counter-arguments. *Conservation Letters, 7*(6), 514–523. https://doi.org/10.1111/conl.12091.
Scott, M., Lennon, M., Haase, D., Kazmierczak, A., Clabby, G., & Beatley, T. (2016). Nature-based solutions for the contemporary city/Re-naturing the city/Reflections on urban landscapes, ecosystems services and nature-based solutions in cities/Multifunctional green infrastructure and climate change adaptation: Brownfield greening as an adaptation strategy for vulnerable communities?/Delivering green infrastructure through planning: Insights from practice in Fingal, Ireland/Planning for biophilic cities: From theory to practice. *Planning Theory & Practice, 17*(2), 267–300. https://doi.org/10.1080/14649357.2016.1158907.
Temmerman, S., Meire, P., Bouma, T. J., Herman, P. M. J., Ysebaert, T., & De Vriend, H. J. (2013). Ecosystem-based coastal defence in the face of global change. *Nature, 504*(7478), 79–83. https://doi.org/10.1038/nature12859.
Threlfall, C. G., Mata, L., Mackie, J. A., Hahs, A. K., Stork, N. E., Williams, N. S. G., & Livesley, S. J. (2017). Increasing biodiversity in urban green spaces through simple vegetation interventions. *The Journal of Applied Ecology, 54*(6), 1874–1883. https://doi.org/10.1111/1365-2664.12876.
Turkelboom, F., Leone, M., Jacobs, S., Kelemen, E., García-Llorente, M., Baró, F., & Rusch, V. (2018). When we cannot have it all: Ecosystem services trade-offs in the context of spatial planning. *Ecosystem Services, 29*, 566–578. https://doi.org/10.1016/j.ecoser.2017.10.011.
Wagenaar, H., & Wilkinson, C. (2015). Enacting resilience: A performative account of governing for urban resilience. *Urban Studies, 52*(7), 1265–1284. https://doi.org/10.1177/0042098013505655.
Wheeler, S. M. (2013). *Planning for sustainability: Creating livable, equitable and ecological communities* (2nd ed.). Abington, Oxon: Routledge.
Wilkinson, C. (2011). Strategic navigation: In search of an adaptable mode of strategic spatial planning practice. *The Town Planning Review, 82*(5), 595–613. https://doi.org/10.3828/tpr.2011.34.
Xu, L., Marinova, D., & Guo, X. (2015). Resilience thinking: A renewed system approach for sustainability science. *Sustainability Science, 10*(1), 123–138. https://doi.org/10.1007/s11625-014-0274-4.