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Articulating a social-ecological resilience agenda for urban design

Mura Quigley , Neale Blair  and Karen Davison

Built Environment Research Institute, Ulster University, Newtownabbey, UK

ABSTRACT

In an era of change and uncertainty, the need for resilience is high on urban agendas. To date, multiple resilience concepts have been adopted into urban design with minimal substantiation. Resilience theory can potentially improve practice by rebalancing contemporary discourses in order to better value procedural aspects of urban design. The paper establishes theoretical links between urban design and resilience, where the integration of social and ecological systems, and the ability to enable adaptability and transformability, are key. In pursuit of shared principles between the two fields, a literature review identifies cross-cutting themes of diversity, social capital, innovation and learning.

Introduction

The resilience agenda has grown significantly in the past 10 years (Meerow, Newell, and Stults 2016) as globalization and urbanization have given rise to complexities in dealing with a wide range of urban challenges (Hambleton 2011). Whilst it can be asserted that the sustainable development agenda has been successful in embedding itself in urban design thinking (Larco 2016), the extent to which 'sustainable' places are resilient and adaptable to future change and uncertainties over time is not clear (Allan and Bryant 2011). The purpose of the paper is twofold: first, to identify the value of urban design for resilience by highlighting areas of common ground between the two concepts, and second, to identify what value, if any, the field of urban design can offer, in order to progress thinking around resilience and advance research in this field. The paper adopts the interdisciplinary understanding of social-ecological resilience and reviews the key concepts of this resilience approach. These concepts are then cross-referenced to literature relating to resilience within an urban context, as well as sustainable urban design literature, and four cross-cutting themes of diversity, social capital, learning and innovation are identified as priorities for mobilizing resilience within the field of urban design. It is posited that the unique socio-spatial tensions existing in urban design can offer insights into how social-ecological resilience research may effectively consider physical change and associated governance processes.

An initial review of what urban design literature says about how to enable resilience within the built environment concludes that there is no clear message or approach that is shared across the field. In many cases, there is confusion around the various narratives of resilience, with a divergence of opinion as to whether the quality of robustness and/or adaptability should be the predominant force at play. In addition, there are issues of scale that have not been resolved within the academic literature, and understandings of how urban design is conceptualized across different spatial, temporal and institutional scales is critical to applying resilience thinking in an urban context.

Insights can be provided by applying a resilience lens to urban design to organize thought around what resilience means in a design context. It is acknowledged that the holistic, political, creative and multi-disciplinary realms within which urban design is rooted, results in it inevitably suffering from a lack of cohesive thinking (Cuthbert 2007). However, given its integrative role within the governance of the built environment of aiding a collaborative and multi-disciplinary approach, could there be a specific and significant role for urban design within a contemporary resilience agenda? Substantive evidence is required to identify the value of urban design for resilience.

It may be argued that the 'resilience turn' of the past 10 years calls for a paradigmatic shift in thinking about planning and design (Cunningham 2013), one where existing traditions and ways of doing things are no longer valid. However, it can be asserted that urban design has always 'done things differently'. Indeed, design is about change, and 'design thinking' (Cross 2001; Çaliskan 2012) operates in an environment with continual uncertainty (Jones 1980). Furthermore, urban design practice is shaped through legislative and political systems (Cuthbert 2006), but is often carried out in an informal and flexible manner where the context of the place should dictate the unique approach used (Beirão, Duarte, and Stouffs 2011). To that end it is important to identify current research that already embeds concepts of resilience thinking, and in doing so, make sure that the connections between resilience and urban design theory are built on strong foundations.

Preliminary analysis of contemporary resilience theory demonstrates that there are sufficient links with urban design to warrant a more in-depth analysis of the shared characteristics between the two contested concepts (Allan and Bryant 2011). The paper goes further than previously published research by establishing, through a qualitative evidence synthesis, a stronger articulation of the connection between urban design and resilience principles. A thematic review of core literature is carried out to identify cross-cutting themes between social-ecological resilience, urban resilience and resilience within urban design. This is an important endeavour because urban design is criticized for being anarchic, insubstantial and based on dogma (Cuthbert 2007; Marshall 2012) and therefore needs to strengthen its theoretical underpinnings. Notwithstanding recent studies indicating the value of a designed approach to place shaping (Carmona, de Magalhaes, and Edwards 2002; Macmillan 2006; Hack and Sagalyn 2011; Nase, Berry, and Adair 2015), there has been a call to substantiate many of the normative principles of urban design (Marshall 2012). As such, current thinking in urban design may be strengthened by drawing on evidence from the social-ecological resilience research community.

The paper explores the relationship between urban design and resilience in four key sections, as shown in Figure 1. Section 1 explores the rationale behind the study and evidences poor links currently between urban design and resilience. Section 2 sets out the research method that is used to attempt to fill this knowledge gap by identifying three

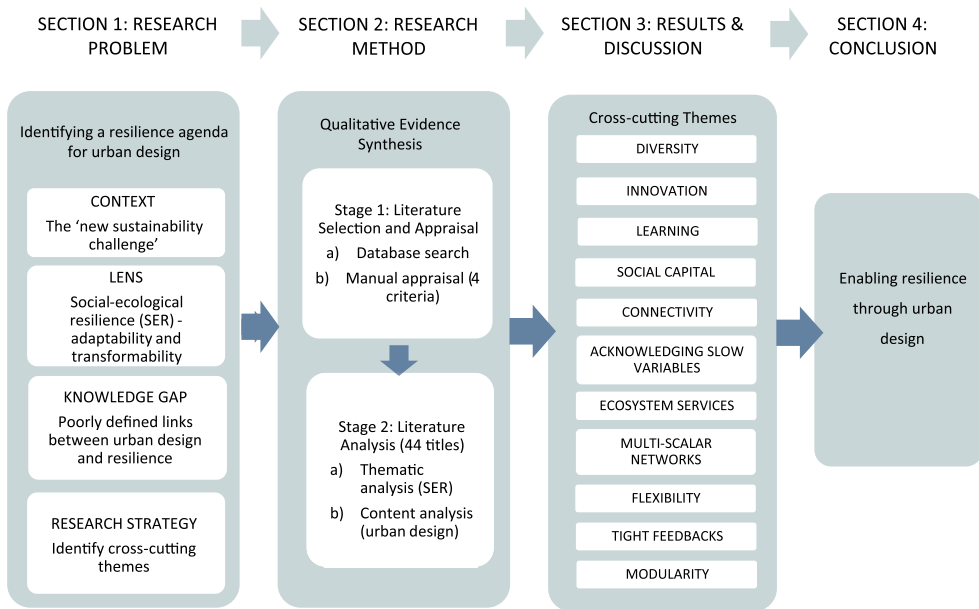


Figure 1. Overview of the paper: a strategy for identifying cross-cutting themes of urban design and resilience. Source: Author's own.

research fields for exploration and comparison. Section 3 identifies and discusses four cross-cutting themes identified from the literature in Section 2, whilst Section 4 discusses the value of the findings, and how a resilience approach may be mobilized within urban design. In doing so, what is particularly evident is that resilience concepts are not new to the field of urban design, and particularly within the sustainable urban design and sustainable urbanism traditions, where social aspects of urban form (Jacobs 1961; Tonkiss 2013) have been argued for some time as important considerations for the shaping of successful places.

The 'new sustainability challenge'

The sustainable development agenda moved into mainstream thought around issues of finite resources and futurity from the 1980s onwards (Du Pisani and Jacobus 2006). The widely adopted and enduring definition of sustainability (Brundtland et al. 1987) suggested that the needs of future generations can be known, and therefore could be accommodated in current consumption processes. Since the turn of the millennium, however, there has been growing recognition of the need to mobilize a 'new sustainability science' (Kates et al. 2001) that addresses the consequences of change (Turner et al. 2003) and takes account of future uncertainties (Leach, Scoones, and Stirling 2010).

It is now widely recognized that human activity's dominance over the environment is causing startling changes, not least the erosion of its rich natural capital at an alarming rate (Pearce and Atkinson 1993; Prugh et al. 1999). There is a need to advance sustainability science to acknowledge change and uncertainty, and meet the needs of the 'Anthropocene' (Crutzen and Steffen 2003), a shifting global trajectory from a period of human growth and influence within the Earth's ecosystem, to one that recognizes that human activities are

profoundly altering many geologically significant conditions and processes (Brauch et al. 2016). A narrative that has arisen with this is the need to think beyond the traditional command-and-control strategies to be able to deal with surprise and uncertainty (Holling and Meffe 1996).

Globalization has accelerated the level of complexity in urban systems as places become more connected, and now has a speed, inevitability and a force that it has not had before (Hutton and Giddens 2000). Part of understanding such complexity, is recognizing that there are multiple framings of goals of development or sustainability, rather than a single path (Leach, Scoones, and Stirling 2010). Understanding urban places as complex adaptive systems can be a useful way of recognizing the need for a new understanding of sustainability, one which takes account of non-linearity (Ludwig, Walker, and Holling 1997), heterogeneity (Adger et al. 2005) and cross-scale interactions (Walker et al. 2004).

A complex adaptive systems approach acknowledges the dynamic properties of inter-linked and embedded systems interacting together at different spatial and temporal scales of the urban system (Walker and Salt 2006). It is this complexity that finds command-and control strategies for satisfying a desired outcome ineffective (Campbell 2011), and that where a change within the system is attempted, shifts and changes occur elsewhere in the system that lead to unforeseen and undetected effects (Boin, Comfort, and Demchak 2010). This increasing complexity and dependencies of urban systems means there are growing pressures and challenges that are increasingly difficult to comprehend and respond to.

Whilst recognition of this new sustainability challenge (Leach, Scoones, and Stirling 2010) has grown, so too has resilience theory. In this context resilience is understood as 'the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks' (Walker et al. 2004, 4). The ability of a system to change and adapt, whilst not collapsing, is critical. This also takes account of a system that comprises linked social and ecological (Berkes, Colding, and Folke 2003) systems, which is argued in the paper as being the most appropriate lens through which to explore urban design.

Notwithstanding the normative position set out above of resilience as a positive property of a system, there are many ambiguities and critiques in this evolving field of resilience research (Ungar 2011; Vale 2014; Meerow, Newell and Stults 2016), not least due to its holistic, integrative and interdisciplinary characteristics. Social scientists rightfully point out that underlying politics of resilience have largely been ignored (Vale 2014; Meerow, Newell, and Stults 2016), and therefore it is important that a thorough understanding of resilience is taken before it is applied directly to an urban design context. Similarly, proponents for a resilience approach argue that as an interdisciplinary approach is sought for resilience, conflict and critique arises (Nkhata, Breen, and Freimund 2008). The following section (see Figure 1, Section 1: Research Lens) outlines three distinct resilience narratives that exist, and makes the case that in the context of urban design, social-ecological resilience is the most appropriate narrative that best aligns with an integrated socio-spatial consideration of urban design.

The evolution of social-ecological resilience

This section tracks the evolution of the resilience perspective, where ideas of multiple steady states, cross-scale dynamics, system learning and memory are gaining traction within various

disciplinary fields (Pahl-Wostl 2009; Barthel, Folke, and Colding 2010). Literature that considers contemporary notions of resilience is evolving in what is described as ‘a resilience renaissance’ (Meerow, Newell, and Stults 2016), and this refocusing builds on previous iterations of engineering, ecological and social resilience concepts (Folke 2006). Different emphases across disciplines are evident today, with the most recent focusing on integrating social (Brown 2014) and ecological sciences (Adger 2000). The defining characteristics of each of these are explored here so that a fully informed understanding of the different definitions of resilience can be identified from the urban design literature. Table 1 highlights the key characteristics of each of the resilience paradigms. It is concluded that because elements of each of the perspectives are still evident today, this leads to confusion in practice, and results in a ‘best fit’ approach where interpretations of resilience are handpicked to suit a particular agenda (Walker et al. 2004; Vale 2014). It is therefore important that the research community is able to distinguish between the perspectives of resilience and the fundamental characteristics, definitions and applications of each (Allan and Bryant 2011; Meerow, Newell, and Stults 2016).

Engineering resilience outlined in Table 1 is characterized by maintaining constancy, withstanding disturbances and returning to a steady state (Folke 2006). Holling (1973) first drew attention to the dual world views of resilience from the more quantitative view of the behaviour of a system, i.e., engineering resilience, to the appreciation of the qualitative understandings that can account for system dynamics, external changes and a better focus on functional persistence than system constancy, i.e., ecological resilience.

The engineering perspective focuses on a strategy of ‘command-and-control’ as a way of managing resilience, and aims to achieve efficiency, constancy and recovery back to a perceived ‘steady state’. It is noted that concepts of engineering resilience are generally inappropriate for understanding and analyzing complex social-ecological systems (Ahern 2011; Campbell 2011) as they do not return to their previous state when perturbed (Holling and Meffe 1996). Instead, social-ecological systems are more concerned with maintaining function whilst allowing the system to change and adapt (Lloyd, Peel, and Duck 2013).

The ecological resilience perspective aligns with notions of renewal, reorganization and development in ecology, and dual aspects of stability (Holling and Meffe 1996). The first (engineering resilience) is characterized by efficiency, constancy and predictability;

Table 1. The three paradigms of resilience thinking and their characteristics.

Resilience paradigm	Characterized by
Engineering resilience	<ul style="list-style-type: none"> • Concern maintaining a ‘steady state’ • Constancy and conservation • Recovery time after disturbance • Maintaining efficiency of function and control of resources in an optimal fashion
Ecological resilience/social resilience	<ul style="list-style-type: none"> • Ecological and social systems considered in isolation from each other • Potential for multiple equilibria • Persistence and robustness • Ability to withstand shocks
Social-ecological resilience	<ul style="list-style-type: none"> • Mutual interaction between ecological and social systems • Multiple and cross-scale interaction • Focus on adaptive capacity and transformative potential • Social learning • Maintaining function whilst adapting

Source: adapted from Lloyd, Peel, and Duck (2013); as derived from Folke (2006).

attributes associated with the concept of 'fail-safe' design (Holling 1973). This view of risk averse design continues to dominate economic theoretical perspectives today (Ahern 2011; Chelleri et al. 2015). The second (ecological resilience) is characterized by persistence, change and unpredictability, and is embraced by those who follow an evolutionary perspective where 'safe-to-fail' is part of the process of emergence and generating solutions (Holling and Meffe 1996).

At the same time as the ecological perspective gained traction within biological sciences, parallel understandings of resilience emerged within the social sciences. Discourses in social resilience such as the need to learn to manage by change rather than to simply react to it, began to be considered within ecology (Folke 2006). Social resilience is defined as the ability of people to cope with external stresses and disturbances arising from social, political and environmental change (Adger 2000). As part of the social resilience perspective, the significant impact that individuals and small groups could play in enabling resilience is discussed (Adger 2000; Folke 2006) and is an important consideration for governance. Despite theoretical advances in social resilience, its utility within management practices remains largely undeveloped (Armitage et al. 2012; Olsson et al. 2015).

As part of an effort to bring coherence to the field, an ongoing school of thought argues that social and ecological aspects of complex adaptive systems should be integrated, and that it is not possible to consider one in isolation from another when applying resilience thinking (Berkes and Folke 1998; Colding and Barthel 2013). Within an integrated social-ecological resilience perspective, uncertainty and surprise becomes part of the game, and you need to be prepared for it and learn to live with it (Carpenter and Gunderson 2001; Berkes, Colding, and Folke 2003; Kinzig and Starrett 2003; Peterson, Carpenter, and Brock 2003). One key difference between previously discussed interpretations of resilience and social-ecological resilience is recognizing the ability of a system to change, adapt and transform (Berkes, Colding, and Folke 2003). Governance approaches in effect should seek to manage and facilitate this change, rather than resist it (Wilkinson 2012). The integration of social and ecological realms within resilience theory marks the evolution from isolated discipline specific interpretations (Ponomarov and Holcomb 2009) to a more collaborative and integrated theory of resilience (Berkes and Ross 2013) as it tries to capture evolutionary concepts of ecosystems, the interplay of social systems within this and adaptive capacity as a measurement of resilience (Engle 2011).

It can be concluded that there has been a shift in recent years to an increasingly trans-disciplinary concept of resilience that integrates physical and socio-political realms of resilience, and emphasizes 'joined-up' approaches to decision making (Coaffee and Clarke 2015) in an urban context. A review of how urban design literature understands resilience is set out in the following section (see Figure 1, Section 1). This review identifies a need to define resilience better in the context of urban design, if it is to be appropriately applied in practice.

Links between urban design and resilience

Urban design is a highly contested and ambiguous field, and therefore difficult to define without an exploration of its various dimensions (Madanipour 2014). As a collaborative and multidisciplinary process of shaping the physical setting for life in cities, towns and villages (Cowan 2005; Urban Design Group 2011) it is primarily focused on spatial outcomes. However,

Table 2. The dichotomy of resilience in urban design thinking.

Characterized by:	Engineering resilience perspective in urban design	Social-ecological resilience perspective in urban design
Conceptualization of the city (Mumford 1965; Marshall 2009)	The city as a machine	The city as an organism
Defining characteristics (Bentley et al. 1985)	Robustness	Adaptive capacity
Resilience approach (Ahern 2011)	Fail-safe	Safe-to-fail
Design emphasis (Madanipour 1997; Hamdi 2004; Inam 2011)	Physical aesthetic	Procedural
Type of city system (Sennett 2006; Batty, 2008)	Closed	Open, complex, adaptive
Governance approach (Hamdi 2004; Campbell 2011)	Top down	Bottom up
Social embeddedness (Newman, Beatley, and Boyer 2009)	Fear	Hope
Urban strategy (Vale 2012)	Maintain status quo	Facilitate evolution
Approach to decision making (Çalışkan 2012; Tonkiss 2013)	Predict and plan	Feedback and learning

Source: author's own.

this is not to be confused with an absence of sociological considerations. Since the 1960s there has been a strong emphasis within urban design on how people understand urban form (Cullen 1961; Lynch 1960), interact with urban form (Jacobs 1961; Alexander 1965), and how it makes them feel and behave (Newman 1971). Research is beginning to unearth the scale of influence that the physical environment can have on a vast range of aspects of life, including health and wellbeing (Ewing et al. 2003; Townshend 2016), economic opportunity (Bell 2005) and social inequality (Talen 2006).

The resilience discourse in urban design is located within the temporal dimension of the field (Carmona et al. 2010). Resilience here is characterized by two trajectories of thinking that have existed for most of the last century: the need for robust built environments that are built to last (Bentley et al. 1985) and the need for adaptable built environments that are flexible and open to change (Montgomery 1998). Table 2 illustrates the characteristics of both traditions of thought about resilience in urban design, highlighting the increasing polarity of governance approaches within the built environment discourses.

The robustness strategy to control and manage change, or even prevent it, leaves little room for innovation and emergence to occur, and allows ineffective models and strategies to persist. On the other hand, a fully bottom-up, self-organized approach does not make provision for some kind of coordination of place-shaping activities at the neighbourhood or city-wide scale. In an age where more than half of the world's population now live in urban areas (United Nations 2015), fundamental to resilience is the need to think about people, along with the cultural, economic and political complexities that are inherent in cities.

Sustainability and resilience

It is recognized that sustainability has become embedded in urban design as the global agenda for balancing social, economic and environmental priorities has come to the fore. Sustainability should be considered early within the planning and design process (Boyko et al. 2006). In fact, recent literature on urban design suggests that not only does urban design build in sustainability, but that urban design now gains its purpose and direction

from a sustainability agenda (Larco 2016) where long-term thinking and futurity are a core goal in delivering places that are well designed. The embedding of sustainability concepts, notions of futurity and whether a place meets the needs of the present without compromising the ability for future to meet its needs (Brundtland et al. 1987) all exists within the same temporal dimension of urban design as resilience (Carmona et al. 2010). Given this link, it is important to consider if resilience concepts are already embedded into sustainable urban design; therefore, such narratives are explored below.

The most dominant approach in the sustainable urban design discourse is that of sustainable urbanism. Whilst it is generally accepted as a wider consideration of sustainable development beyond urban design, it plays a clear role in advocating for normative aspects of urban design that define 'what is good urban form' (Prince's Foundation 2007; Farr 2011; Haas 2012; Larco 2016). However, within the sustainable urbanism discourse there is no consistency in how resilience and sustainability relate to one another. Vale (2012) argues that sustainable urbanism is about maintaining the status quo, whereas resilience is about evolution and efforts to improve the system. In contrast, Sharifi (2016) brings resilience and sustainability together under the collective banner of sustainable urbanism by describing it as the application of sustainability and resilient principles to the design, planning and administration/operation of cities. A further perspective advocates for sustainable urbanism principles as the foundation to achieving resilient cities (Newman, Beatley, and Boyer 2009).

The roots of sustainable urbanism lie somewhere between the ecological turn in urban design (McHarg and Mumford 1969) and the social considerations of place (Jacobs 1961). What is not clear is how notions of change, uncertainty and adaptation are integrated into design processes that employ principles of sustainable urbanism. More recently there has been an attempt to shift concepts of sustainable urbanism to embrace concerns of resilience, such as anti-fragility and uncertainty (Roggema 2016), and within that a strong case is made for adaptable urban form.

Whilst there may be other contrasting perspectives of the relationship between urban design, sustainability and resilience, literature also highlights confusion and ambiguity in understanding the theory and concept of resilience as applied within urban design. It is suggested that resilience represents a paradigm shift in sustainability thinking, and has arisen due to the observation of the effects of climate change and growing uncertainties that globalization and urbanization give rise to (Hambleton 2011).

Identifying cross-cutting themes

Literature reviewed in this paper highlights the varied discourses within urban design relating to concepts of resilience, and demonstrates the dichotomy that exists between robustness and adaptability, as well as a clear lack of integration between social and ecological systems. It raises important questions about urban design in relation to resilience thinking, not least whether it is possible to design with two conflicting qualities such as structure and flexibility in mind, using temporal and spatial scales, as well as the unique context of the place that should determine the most appropriate approach for enabling resilience. There is a clear gap in understanding if urban design currently embeds resilience thinking, and this is demonstrated above through the divergent interpretations of resilience. It appears that urban design as a field has not kept up to speed with the pace of development of the resilience agenda, and as a result has had to adopt key concepts using a best-fit approach.

It is important that this research gap is filled, because without doing so, urban design continues to import concepts, ideas and principles that are not properly substantiated in evidence. This is a current problem for the field (Marshall 2012) and thus it continues to be undervalued, overlooked and strongly criticized. Urban design must move away from being fragmented by disciplinary boundaries and beyond its reliance on principles that are not fully substantiated in a robust evidence base.

For the field of urban design to successfully contribute towards an advancement of resilience thinking, it must explore its linkages to contemporary resilience thinking. Urban design must look outside of its own domain to engage in theoretical discussions that are currently underway within the resilience literature, otherwise it may continue to promote and adopt normative principles that remain insufficiently substantiated. Similarly, the narratives of resilience in urban design must go beyond simple definitions of 'building to last' or 'adapting to change over time' to exploring the embedded concepts, principles, rules and defining characteristics of the contemporary resilience discourse to date.

Methods

The discussion above highlights the need to apply a resilience lens to the field of urban design so that contemporary resilience concepts can be identified and defined within urban design. Therefore, the aim of the study is to identify cross-cutting themes between resilience and urban design literature. It does so by conducting a literature review of three key fields of inquiry: social-ecological resilience, urban resilience and urban design. Social-ecological resilience is argued as being the most appropriate area of resilience literature for inclusion in the study as it aligns most appropriately to current discourses on urban design, namely that urban design considers both process and product (Madanipour 1997; Lang 2005) and that as a field of inquiry acknowledges change (Moudon 1992; Carmona 2014), complexity (Marshall 2009; Vale 2014) and uncertainty (Roggema 2016).

Within the study the key questions used to frame the research approach are: (1) what are the cross-cutting themes of resilience across general resilience literature, literature relating to urban resilience and the sustainable urban design/urbanism literature? (2) Are the common themes identified discussed similarly across all the literature, or are there dominant narratives that directly apply to urban design? (3) What are the dominant themes of resilience that urban design should be most concerned with? In order to answer the above questions a qualitative evidence synthesis approach was adopted to identify and analyze the relevant literature.

In order to ensure a robust literature review was carried out, a two-stage process of literature selection and analysis was adopted, as shown in Figure 1. First, relevant peer-reviewed literature was searched for using web-based bibliographic databases (Elsevier's Scopus and Thomas Reuter's Web of Science). A number of key words were applied, as detailed in Table 3. Various combinations of the key words were searched to ensure interchangeable terms such as urban design/urbanism and city/urban were returned in the literature search. In addition to the web-based literature search, interactions at academic network events led to the identification of a small number of additional resilience texts that had not been returned in the search, but that satisfy the selection criteria. Incorporating significant texts identified by academics familiar with this field of research led to the creation of a more robust resource from which to interrogate key resilience themes.



Table 3. Process of identifying and selecting appropriate literature for the review.

Literature identification phases	Search entry	Studies identified	Studies discarded	References	Studies added (texts/ supplementary papers)	Studies selected
Phase 1: selection of general resilience studies	'Social/people ecosystem/ ecological resilience'	n = 11	n = 1	Berkes, Colding, and Folke 2003 Walker et al. 2004 Adger et al. 2005 Folke 2006 Walker and Salt 2006 Smith and Stirling 2010 Wilkinson 2012 Armitage et al. 2012 Lloyd, Peel, and Duck 2013 Schlüter et al. 2015	Holling 1973 Levin et al. 1998 Gunderson 2000	n = 13
Phase 2: selection of urban resilience studies	'Urban/city/ community resilience'	n = 15	n = 1	Newman, Beatley, and Boyer 2009 Ernstson et al. 2010 Ahearn 2011 Leichenko 2011 Collier et al. 2013 Pickett et al. 2014 Vale 2014 Caputo et al. 2015 Chelleri et al. 2015 Coaffee and Clarke 2015 Beilin and Wilkinson 2015 Goldstein et al. 2015 Meerow, Newell, and Stults 2016 McElduff et al. 2016	Harrison et al. 2014 Hambleton 2015	n = 16
Phase 3: selection of resilience studies that discuss specifically urban design	Urban, design, urbanism, sustainable, resilience	n = 13	n = 2	Carmona 2009 Karlénzig 2010 Allan and Bryant 2011 Allan et al. 2013 Dobson and Jørgensen 2014 Roggema 2014 Spirn 2014 Childers et al. 2015 Crowe, Foley, and Collier 2016 Larco 2016 Roggema 2016	Fair 2011 Vale 2012 Cunningham 2013 Ahearn, Cilliers, and Niemelä 2014	n = 15

Source: author's own.

A manual filtering of the literature took place based on a set of selection criteria. These were that: (1) the literature clearly adopted an integrated conceptualization of social-ecological resilience; (2) the literature title specifically mentioned one of the three themes of resilience as detailed in Table 3; (3) the literature was concerned with identifying key themes or characteristics of resilience within that specific area and did not focus on a single attribute or principle of resilience; and (4) only literature published following the publication of Holling's seminal work on resilience in 1973 can be considered. The date applied in the final criterion is important, as it represents the introduction of the contemporary understanding of resilience that is adopted in the paper, and is used here following similar studies that have validated this as an appropriate date from which to draw literature from (Meerow, Newell, and Stults 2016). After the literature was identified and appraised, a total of 44 sources of literature resulted and were taken forward for analysis, as detailed in Table 3.

The second stage of the literature review adopts a qualitative synthesis approach (Grant and Booth 2009) as a method for integrating the findings from qualitative studies that looks for themes or constructs within or across individual qualitative studies. Initially, a list of 19 resilience attributes are identified from the selected resilience literature, which are consolidated and refined into a list of 11 themes of resilience traits or characteristics. Next, a search through urban resilience literature reveals what key characteristics are discussed from the initial list that are more relevant to an urban context. Finally, an analysis of the sustainable urban design/urbanism literature is carried out, to identify what themes in the initial list relate to the field of urban design. In reviewing the literature selected in the first stage selected in phase one, cross-cutting themes of resilience are identified from the literature sources.

Results

From the list of 11 attributes of resilience, the four themes that feature most in the urban resilience and urban design literature were diversity, social capital, learning and innovation. A discussion of the four themes follows to include definitions, context, meanings and the identification of areas of conflict in understanding between general resilience, urban resilience and urban design. Table 4 tracks the four cross-cutting themes within the context of the three above areas and provides an overview for the following discussion of each theme in detail.

It should be noted that the above themes do not represent all shared attributes that exist between the three fields, but those that are most prevalent in the sources reviewed. Urban design is distinguished from other place-shaping activities in relation to resilience as it is collaborative (George 1997; White 2015), multi-disciplinary (Bentley 1998; Cuthbert 2003) and operates across a range of spatial scales (Batty 2009; Larco 2016), and therefore unique insights can be offered from this analysis on how these themes are discussed in the literature reviewed. These are discussed in turn below.

Diversity

Across the three literature themes, diversity appeared consistently in almost all sources across all three themes (Levin et al. 1998; Cunningham 2013; Beilin and Wilkinson 2015). In

Table 4. Cross-cutting themes within social-ecological resilience, urban resilience and resilience within urban design.

Resilience attribute	Social ecological resilience	Urban resilience	Resilience within urban design
Diversity	The different types of components that make up a system; two types: functional and response	The range of actors and institutions involved; diversity of approaches within institutional arrangements	Functional diversity in terms of general adaptability over time (adaptive capacity); response diversity in terms of adaptation after a disaster or event
Social capital	Promote trust, well-developed social networks, and leadership; build capacity of people to respond, together and effectively to change disturbance; strong penalties for cheaters	Need for well developed, multi-level social networks; meaningful collaboration and leadership to break through institutional inertia	How urban morphology affects capacity to respond to change; ability for collective action to occur
Innovation	Experimentation, locally developed rules, embracing change; assistance to change rather than subsidies not to change	Piloting new ideas as experiments as 'safe-to-fail' before big investments occur	Design as innovation; iterative design processes to allow testing of ideas; temporary changes to urban form to test outcomes
Learning	Degree to which the system can build and increase the capacity for social learning of critical relationship between behaviour and the environment; accumulation of system memory	Learning through experience; feedback to adapt governance approaches towards greater effectiveness; collaborative engagement	Adaptive design with experimentation; learning through experience of engagement and collaboration across professional silos and wider stakeholders; emphasis on design process

Source: author's own.

social-ecological resilience literature, diversity is defined as 'the different kinds of components that make up a system' (Walker and Salt 2006, 163). There are two different types of diversity within social-ecological resilience: functional diversity and response diversity (Elmqvist et al. 2003). Functional diversity relates to the range of functional groups that a system depends on and underpins the performance of the system (Walker and Salt 2006). Response diversity is the range of different response types that exist within a functional group (Gunderson 2000). This distinction largely relates to temporal aspects of both urban design and resilience, as conceptualized by Stirling's (2005) dynamic properties of sustainability, where the temporality of change ranges from one of a 'transient disruption' to a longer term 'enduring shift'.

Within the social-ecological resilience literature it is widely accepted that the promotion and sustainability of diversity is a desirable system characteristic (Walker and Salt 2006) and that multiple forms of land and other resource uses should be encouraged as part of a resilience agenda. Diversity in social-ecological systems has been drawn from evolutionary science that understands if there are multiple functional components within a system, and one component fails, there are others to ensure the system continues and adapts to enable a further component to pick up on the functional task required.

Diversity in urban resilience is a highly valued characteristic of the system, as can be seen by its widespread recognition across the literature. An example of functional diversity can be found in land use. Where an area has a variety of different land uses, there is diversity in the components that provide the function of service to a population, e.g., jobs, shops, schools, housing etc. What can be observed from the last 10 years is an increasing

vulnerability of retail, and as a land use it is continuing to decline in many urban areas. If an area has diversity in terms of its land use functions, then the urban system is less likely to fail than if it was wholly dependent on retail for its function. Where retail may decline, other land uses over time can grow to fill the functional gap left in the area. This is an example of functional diversity.

Response diversity in urban environments refers to the range of tools that are used to respond to an event that initiates a need to act. This may be a flooding event or a need for regeneration in an area. Within urban design, response diversity may relate to the morphology of a place and how the urban form may promote or inhibit a diverse range of responses by a community to recover from the event and embed learning for future events that reduces both the impact and the response time (Karlenzig 2010; Allan et al. 2013).

The distinction between response and functional diversity is important for urban design in adopting a resilience approach, and through the useful distinction between adaptation and general adaptability by Meerow, Newell, and Stults (2016) it is possible to clarify this dichotomy in terms of how diversity interacts within a resilient system. Adaptation takes place in response to a shock on the system, such as a flood or a terrorist attack, and a change is made to the system so that it learns from that event and builds in resilience to deal with it more effectively next time. However, general adaptability over time is more dependent on functional diversity to deliver resilience, and this is also known as adaptive capacity (Folke 2006; Caputo et al. 2015). Meerow, Newell, and Stults (2016) argue that adaptive capacity is the dominant theme of urban resilience, and extending from that it is suggested that functional diversity is also the dominant theme of urban design that seeks to enable such urban resilience.

Social capital

Across the three literature themes, social capital was posited as a key component of resilient systems (Collier et al. 2013; Lloyd, Peel, and Duck 2013; Childers et al. 2015) in most of the sources analyzed. Social capital is understood widely to involve trust (between individuals and of institutions), mutual tolerance and involvement (Putnam 1995), and is also referred to as an overlap in governance from a property rights perspective (Ostrom et al. 1999), where multiple stakes exist on a given piece of land, and therefore there is a need to work together within a social-ecological system. Embedded within this theme is the valuing of collaboration as necessary to effect economic and political change (Putnam 1995).

Within the social-ecological resilience literature, social capital also adopts this definition, but emphasizes the function of social capital as connecting to environmental systems and the ability to bring together collective action for physical change. Trust, strong networks, social memory and leadership are all important components of social capital that build the capacity of social-ecological systems to adapt and change shape (Folke 2006; Walker and Salt 2006).

The urban resilience literature is also in agreement with the above understandings of social capital; however, some of the governance problems that reduce the effectiveness of mobilizing social capital are identified. These include bureaucratic inflexibilities (Pickett et al. 2014) and institutional inertia (Schlüter et al. 2015). There is also agreement that social capital in urban systems is required, and is a part of adaptive strategies that enable change and build resilience (Adger et al. 2005; Caputo et al. 2015). In fact, well developed social

capital is considered an essential ingredient for resilient communities, particularly in terms of bonding (group cohesion), bridging ties between groups and linking multi-level relationships (McElduff et al. 2016).

There are two key arenas within which social capital relates to urban design under a social-ecological resilience lens. This is first in terms of morphology (Allan et al. 2013) where, as discussed above, urban form has a bearing on how actors can respond to disturbances such as the physical decline of an area or changing demographics (Caputo 2013). The second is where social capital is highlighted as crucial for collective action to occur (Dobson and Jorgensen 2014). Indeed, collaboration is a fundamental theme of sustainable urban design and so the ability and nature of this collaboration to enable adaptability to respond to change is where urban design comes into its own in terms of resilience.

Sustainable urban design is defined as a process whereby all the actors work together through partnerships and effective participatory processes to integrate functional, environmental and quality considerations to design, plan and manage a built environment that respects the existing culture, heritage and social capital of places, whilst avoiding conservation for its own sake (European Union 2004; Carmona 2009). To act as part of the urban system and effect meaningful change, the development of social capital to enable collaboration is essential.

Innovation

Across the three literature themes, innovation was also identified as a critical component of social-ecological resilience (Berkes, Colding, and Folke 2003; Carmona 2009; Goldstein et al. 2015). Within the social-ecological resilience literature innovation is important for the facilitation of emergent behaviour to occur. A system disturbance has the potential to create opportunity for doing new things and for new tools that facilitate more resilient behaviour (Folke 2006).

Despite a clear value being placed on innovation within society, many current governance mechanisms are about providing subsidies not to change, rather than assistance to change (Walker and Salt 2006; Carmona 2009). This is particularly prevalent within the heritage industry where both preservation and innovation manifest themselves in some of the most valued places in society. It is important to address system behaviour that reduces diversity and choice, and instead fosters emergent behaviour where innovation to adapt is facilitated. A resilient system would therefore value and subsidize experimentation (Walker and Salt 2006), and this should be coupled with subsidiarity, i.e., operationalized at the lowest scale of governance feasible. Institutions that become stagnant and slow to respond to a call for change are ineffective at fostering emergent behaviour.

The narrative of innovation is similar when explored from an urban resilience lens. Urban areas are argued as sites of innovation and laboratories for resilience (Meerow, Newell, and Stults 2016), and in the literature innovation is discussed particularly in relation to transitioning to greater sustainability (Leach, Raworth, and Rockström 2013). Cities must realise the importance of innovation within a resilience narrative, and harness its potential in ways that will enable adaptive capacity (Ernstson et al. 2010). Within urban governance literature, innovation and leadership become intertwined, and it is argued that innovation for enabling resilience can be facilitated by working across institutional silos (Hambleton 2015).

A collaborative approach to operationalizing urban resilience can be conceptualized as adaptive co-management and co-design (Crowe, Foley, and Collier 2016) which, it is argued is fertile ground for innovation to occur. Within the urban resilience literature, and directly related to urban design, it is argued that 'safe-to-fail' experiments within an urban context can allow for testing and redundancy required to find the optimized environmental conditions necessary for an urban system (Ahern 2011). The key to the safe-to-fail approach is small scale (Gunderson 2000; Campbell 2011). The value of a collaborative approach in delivering urban innovation is also recognized, where new forms of urban enterprise emerging from collective creativity are posited as a type of entrepreneurial urbanism to form an adaptive and emergent way of shaping places (Dobson and Jorgensen 2014).

Indeed, design itself is innovation, as it deals with an unknown future, and a set of design problems that must be turned into deliverable design solutions. Design is also an iterative process, where ideas are generated, tested and refined. Redundancy is facilitated so that solutions that achieve desirable outcomes are kept, and those that do not are discarded. The result of an iterative design process is innovation, and it breaks through the institutional inertia that stands in the way of being able to adapt over time.

Learning

Across the three literature themes, almost four-fifths of the sources discuss learning as an important component of an integrated social-ecological perspective (Ernstson et al. 2010; Ahern 2011; Childers et al. 2015). The main type of learning referred to in the literature is social learning (Macmillan 2006; Ahern 2011; Beilin and Wilkinson 2015; Goldstein et al. 2015), which is defined as a two-way causal process between behaviour and the environment (Bandura 1977). This is best understood through the growing support for the view that social behaviour in part creates the environment around it, i.e., places are socially constructed, and that the resultant environment, in turn, influences behaviour.

The types of learning discussed in relation to resilience include learning processes (Adger 2005; Armitage et al. 2012), learning capacity (Adger et al. 2005; Folke 2006), collaborative learning (Wilkinson 2012), continuous learning, reflexive learning (Beilin and Wilkinson 2015), accumulation of system memory (Beilin and Wilkinson 2015; Crowe, Foley, and Collier 2016), learning-by-doing (Collier et al. 2013; Ahern, Cilliers, and Niemelä 2014), critical learning (Goldstein et al. 2015), experiential learning (McElduff et al. 2016), learning environments (Macmillan 2006), learning as an agent for change (Goldstein et al. 2015; McElduff et al. 2016) and mutual learning (Childers et al. 2015).

The most predominant theme within the social-ecological resilience literature in relation to learning is the important role it plays in enabling adaptive capacity. As Folke (2006) explains, resilience is in part defined by the degree to which the system can increase its capacity for learning, with a key challenge being the building of learning capabilities into institutions and organizations. There is a need for a focus on the processes (Folke 2006) of learning, as well as the necessary conditions and the creation of appropriate learning spaces (Lloyd, Peel, and Duck 2013) that can enable the system to respond effectively. Learning is also intimately tied to the ability of a system to accumulate memory over time (Beilin and Wilkinson 2015) and for this to occur, an adaptive co-management approach is necessary. This is achieved through collaboration and working across disciplines, which facilitates the

accumulation of different types of knowledge, and is a key strategy for resilience (Wilkinson 2012).

Trial and error is proposed as the default model for learning, where people learn and adapt through the simple process of experience (Gunderson 2000). This is further elaborated in the urban resilience literature where Ahern (2011) strongly advocates for learning from modest failures through his 'safe-to-fail' approach to adaptive planning and design. Here, learning-by-doing is given a pivotal role in transitioning to urban resilience (Collier et al. 2013) and a warning to planning professionals going forward of the need for truly collaborative community engagement approaches.

Collaborative learning requires the active engagement of a diverse range of stakeholders and knowledge practices. Stakeholders need to build skills in critical thinking and coordination so that one set of interests is not imposed on everyone. When practised effectively, learning can break from siloed mentalities (Goldstein et al. 2015). Appropriate learning environments are also highlighted as important, and this extends to the effective collaborative design of institutional environments such as schools (Macmillan 2006), but also the creation of the public realm (Caputo 2013).

A further theme emerging from literature is the need to understand the past, the historical narrative and embedded learning within that (Ahern 2011; Caputo 2013; Crowe, Foley, and Collier 2016). It is this social memory that needs to be given the space, time and resources for social learning to take place. As Ahern, Cilliers, and Niemelä (2014) explain:

Adaptive design with its experimental approach can help planning professionals to practice learning-by-doing while keeping in mind that planning is not a science, but social action with scientific, technological and legal underpinnings. (255)

The statement above reinforces the message weaving throughout this paper that a shift is needed to rebalance the scales of emphasis towards social process and away from a purely aesthetic conversation in urban design.

Discussion

An analysis of cross-cutting themes of urban design and resilience allows for an understanding to be developed of how urban design currently considers, values and embeds concepts of resilience within its thinking. Four themes that showed greatest prevalence in the social-ecological systems literature are diversity, social capital, innovation and learning.

In progressing a social-ecological systems perspective in urban design, it can be established that the relationship between resilience and sustainability requires further exploration. Currently, variations of thought identify resilience as: (a) a subset of sustainability; (b) another expression of sustainable urbanism; and (c) of equal weight with sustainability. This is a cause of confusion within the literature and therefore represents an important area for future research. An exploration of social-ecological interactions, and what this means within the context of urban design, highlights some important considerations in moving beyond a sustainability agenda for urban design and integrating social-ecological resilience thinking.

Another area of ambiguity is the 'process-versus-product' debate that continues to confuse the field of urban design, with some favouring the idea that its true value lies within its processes; how it engages people, builds social capital, learning and civic stewardship. On the other hand, it is contended that without a strong focus on physical aesthetic, urban design loses its purpose as adding physical form to place-shaping processes. The

'procedural-versus-spatial' debate described here is recognition of the paradoxical nature of the field and its attempt to be 'everything and anything' (Lang 2005; Cuthbert 2011). If we accept such paradoxes exist, and even go further to argue that both are necessary to maintain a holistic approach to shaping place (Hamdi 2004; Carmona 2014), this dialectic takes on a new trajectory of thought when a resilience lens is applied. An integrated social-ecological model of resilience, where social systems and physical systems are at play together in a complex web of interactions, provides an arena for discussion of the dynamics between the physical and the non-physical elements of urban design.

Three conceptualizations of such social-ecological interactions that manifest themselves in the urban arena are how society shapes space, how society interacts with space and how space shapes society's feelings, behaviour and opportunities. Whilst it is not the intention here to explore these in detail, it is important to recognize that they exist at various spatial and temporal scales and collectively define the interactions between systems that are recognized within a social-ecological resilience model. Alignment between resilience and urban design theory may further progress knowledge in this area and potentially make a case for greater investment in effective urban design processes.

In addition to the above, scale is identified as a fundamental characteristic of social-ecological systems and takes three forms when viewed through a resilience lens in urban design. Spatial scale is the most obvious, and it is from where an urban design activity draws its direction and purpose (Cuthbert 2006). The temporal scale is where resilience over time is understood within a social-ecological model. Governance scales are also important in understanding who truly holds the power within decision-making processes, with power already identified to be at the core of urban design activity (Carmona 2014). All these scales play a dominant role in delivering resilience, particularly the interlinkages between them. There is a substantial body of evidence that emphasizes the importance of cross-scale interactions, and in urban design, spatial, temporal and governance scales must be explored in investigations of resilience going forward.

Conclusion

The purpose of the paper was to identify a resilience agenda for urban design and identify what value, if any, the field of urban design can offer to resilience research. An analysis of social-ecological resilience has been carried out – resilience as it applies to urban environments and resilience within the current urban design literature. The comparison of cross-cutting themes between the three realms allows for the translation of resilience concepts and terminology into urban design. It has been shown that key resilience concepts are evident within urban design; however, important questions are also raised about the current position of resilience within sustainable urban design. The multi-disciplinary nature of urban design may be able to offer resilience ideas of how to break disciplinary silos and encourage collaboration towards shared principles of resilience within urban design.

The foundations for understanding what the key considerations in urban design theory are for embedding a resilience agenda are laid out here, and evidence the unique and significant role for urban design going forward with a resilience agenda. Research should acknowledge both social and environmental systems as integrated. Strengthening the connections between urban design and resilience theory means both fields can build better foundations for addressing new sustainability challenges of responding and adapting to

change. This allows for the delivery of a balanced, integrated and holistic approach to shaping places that have a clear structure and purpose, but can innovate and adapt to the changing needs of society which are increasingly uncertain in a globalizing and urbanizing world.

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ORCID

Mura Quigley  <http://orcid.org/0000-0003-3728-9015>

Neale Blair  <http://orcid.org/0000-0002-6226-5958>

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