Defining resilience:
Background paper for the Resilient Urban Futures programme

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The Resilient Urban Futures research programme brings together a multi-disciplinary group of researchers focused on a key issue for New Zealand – how to develop vibrant, liveable, competitive and resilient cities into the future. The research team is led by the New Zealand Centre for Sustainable Cities and links universities, research organisations, and government and community end-users. For more information, go to www.resilienturbanfutures.org.nz.

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Introduction

'Resilience … is such an everyday word that it often comes with a set of implicit assumptions: that everyone understands the concept in the same way and that it is somehow like sustainability' (Allan & Bryant, 2011, p. 38). Resilience is a term with a range of definitions and uses, given different modifiers (community, disaster, ecological etc.), and addressed from a variety of perspectives (Shea, 2013). Simmie and Martin (2010), reviewing resilience literature, note that partly due to its relatively recent emergence as an analytical concept there is no universally agreed definition of resilience in social sciences.

This briefing paper is intended to inform discussion within the RUF programme, by providing a common base understanding of resilience generally but also resilience in the urban context, in the expectation that it may contribute to greater integration of the research programme.

Differences and inconsistencies in use of the concept may indicate intellectual vigour and creativity, or may hamper research (Nelson, 2011), but the malleability of the term has implications for the policy outcomes which might be justified in its name (Davoudi et al., 2012). Here, definitions of resilience have been grouped into commonly used categories, although these categories are somewhat artificial and may be thought of as points on a continuum of interpretations. As well as definitions, there is a body of literature on resiliency indicators and conditions, which is outside the scope of this paper, but could be the subject of a subsequent paper.

Individual resilience

A common dictionary definition of resilience is the individual's ability to recover quickly or adjust easily to adversity or change. There is a large body of research in social and psychological sciences that focuses on the resilience of individuals to recover from stress, shocks, disorder or poverty (Armitage, Béné, Charles, Johnson, & Allison, 2012). This discussion paper will, however, focus on community and system resilience.

Engineering resilience

Resilience was used by physical scientists to denote the characteristics of a spring and describe the stability of materials and their ability to return to original form and position after being bent, compressed or stretched. The concept was later adopted by many other disciplines.

Holling defined engineering resilience as the ability of a system to return to an equilibrium or steady state after a disturbance, which could be a natural disaster or a social upheaval (Davoudi et al., 2012, citing Holling 1973, 1996). The focus is on behaviour near a single stable equilibrium, on speed of return time to equilibrium after disturbance, on maintaining efficiency of function and constancy of the system, and on predictability (Folke, 2006).

Many references in government statements and in everyday use are based on the engineering view of resilience as bouncing back (Davoudi in Davoudi et al., 2012). Simmie and Martin (2010) note that engineering resilience bears close affinity with the use of equilibrium in mainstream economics. This view of resilience is about resisting disturbance and change to conserve what existed before, often addressed in terms of recovery (Folke, 2006), and can be linked to disaster resilience, see below.

Ecological resilience

This has its roots in 1960s and 1970s studies, for example of interacting animal populations. In this view, ecological systems are bounded by thresholds that may be triggered or crossed by nonlinear and abrupt responses to particular events or through aggregate change over time (Nelson, Adger, & Brown, 2007). Periods of gradual change are followed by periods of rapid change triggered by disturbance. Holling defined ecological resilience as 'a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist' (Folke, 2006, citing Holling, 1973, p.17) and as 'the magnitude of the disturbance that can be absorbed before the system changes its structure' (Davoudi et al., 2012 citing Holling 1996, p. 33). The focus is on persistence, robustness, and ability to withstand shock and maintain function. This is not just time to bounce back, but how much disturbance a system can take and remain within critical thresholds.

Common to both engineering and ecological resilience is the notion of the existence of equilibrium, but a main difference in the ecological view is the existence of multiple equilibria in natural systems and the possibility that systems may flip into alternate stability domains (Davoudi in Davoudi et al., 2012; Folke, 2006). A resilient system may undergo significant fluctuation but will either return to the old state or a new stable state, one better adapted to new conditions. In a policy sense, the shift is from aspiring to control change in systems assumed to be stable to managing the capacity of systems to adapt to change (Folke, 2006). Resilience is not a fixed value but varies in line with changing internal and external conditions (Nelson, 2011).

Acknowledging that returning to a stable state is less important than maintaining system integrity, a common working definition is: 'the capacity of a system to absorb disturbance and reorganise while

undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks' (Allan & Bryant, 2011; Folke, 2006, both citing Walker et al. 2004). This emphasises constructive adaption to changing conditions rather than the ability to recover from a shock.

Socio-ecological (social-ecological) resilience

This term refers to attempts to integrate social dimensions in a resilience framework and consider the ability of human communities to withstand external shocks to their social infrastructure (Folke, 2006). Social and ecological systems may be understood as related, coupled systems. Social systems, like ecological systems, are bounded by thresholds that may be triggered by nonlinear and abrupt responses to particular events or through aggregate change over time. For example, a high profile flood event may trigger a change in socially acceptable policy responses (Nelson et al., 2007).

Folke (2006) reviews the literature addressing social resilience and argues the advantages of stressing linked social-ecological systems. If studying only the social domain, a human society may seem to show great ability to cope with change, but such adaptation may be at the expense of changes in the capacity of ecosystems to sustain the adaptation, generating breakpoints in system resilience. Studying the ecological domain only may lead to narrow conclusions without consideration of economic or cultural values or the learning and flexibility of the social system when confronted with ecosystem change.

Resilience is defined as:

1. the amount of disturbance a system can absorb and still remain within the same state or domain of attraction;
2. the degree to which the system is capable of self-organisation; and
3. the degree to which the system has the capacity for learning and adaptation (Folke, 2006 citing Carpenter et al. 2001; Nelson et al., 2007).

The focus is on networks, social learning, innovation and adaptive capacity.

This has been influential in a range of disciplines. For example, Manning et al. (2011, p. 11) adopt an IPCC (2007) definition in their discussion of climate change:

> Resilience is defined as the ability of a system to absorb disturbances while retaining the same basic structure, ways of functioning and self-organisation. In other words, a resilient system is a system that has minimised its vulnerability through successful application of adaptive capacity, including through autonomous and planned adaptation measures.

Adaptation, resilience and uncertainty

Efforts to foster socio-ecological resilience include identifying and managing controlling variables that determine the dynamics of the system, identifying the shocks or processes that may destabilise these variables, and identifying the points at which thresholds are reached (Armitage et al., 2012). Because system complexity and unanticipated events make recovery trajectories difficult to predict and unique, alternative concepts to that of "recovery" are "renewal", "regeneration" and "reorganisation" (Folke, 2006).

Nelson (2011) distinguishes between specific capacities for responding to particular risks, for example a flood early warning system, and generic capabilities, which are not specific to particular risks but which help to increase options and flexibility to respond to a variety of challenges, for example education. One vein of research is how to identify a proper balance of investments in

specific and generic capabilities in order to maintain system resilience. Following this, specific resilience entails identifying the alternate system regimes, thresholds, controlling variables and anticipated shocks in order to identify the types of capabilities necessary to avoid crossing thresholds. General resilience is the capacity of the system to deal with unidentified shocks or a multiplicity of pressures.[2]

As the nature of future change is uncertain, there is a need to maintain flexibility to respond and to avoid future loss of options. This definition of resilience can be 'the capacity of a system to absorb disturbances and still retain the same structure and function, while maintaining options to develop' (Nelson et al., 2007 ; quotation in Nelson, 2011).

Losing resilience implies loss of adaptability. However, there is a tension between achieving high adaptation (with efficient adaptation to a specific risk or situation) and maintaining system resilience (with flexibility to respond to various challenges and unexpected shocks). Adaptation can undermine resilience through downstream effects (adaptation in one location may decrease resilience in another location), loss of response diversity, and over-specialised adaptation (so that a system is so tuned to a particular type of shock it becomes vulnerable to other unknown shocks) (Nelson et al., 2007 citing Walker et al 2006). Apparently adaptive responses which undermine resilience tend to be framed within a narrow, technological perspective, those implemented through top-down governance structures, or in which the system is not sensitive to feedbacks.

Insensitivity may result from consequences being displaced in space or time or because the consequences are masked by other productivity gains. Inclusive actions which recognise the importance of multiple drivers, which include a wide variety of actors across scales, or which are responsive to feedbacks tend to enhance overall resilience. Insensitivity in this sense is related to the inflexibility characterised by some as "lock-in", or the tendency of an efficient system to be locked into one dominant pattern of behaviour (Scheffer and Westley 2007).

Transformability and evolutionary resilience

The distinction between socio-ecological resilience and evolutionary resilience is somewhat blurred. 'The resilience approach is founded on the understanding that the natural state of a system is one of change rather than one of equilibrium' (Nelson et al., 2007 citing Holling 1973). Resilience can be seen as "bouncing forward" with constant reinvention, rather than "bouncing back" and interpreted as an evolutionary concept and as an on-going process rather than a characteristic or a recovery to a pre-existing or new stable state (Shaw in Davoudi et al., 2012; Simmie & Martin, 2010).

Davoudi (2012) sees parallels between this view of resilience which discourages fixity and rigidity and the interpretive approach to urban planning which discourages the modernist "will to order". Simmie and Martin (2010) draw on evolutionary economists who consider that economies can never be in equilibrium as they are based on and driven by knowledge, which constantly changes. They argue that 'any convincing theory of regional economic resilience must explain how a regional economy's resilience evolves as well as how its resilience impacts back on that economy's evolution' (Simmie & Martin, 2010, pp. 30–31). Resilience defined as how well a regional system adapts its structure and function in response to disturbance is more easily reconciled with the idea of regional economic evolution than the definition of resilience as the ability of a regional economy to retain its structure and function despite disturbance (implying the more resilient, the less change over time).

[2] From comments received from Anaru Waa, May 2013: There might be generic determinants of resilience and situation-specific determinants. If there are generic determinants, these might be a common thread across the Resilient Urban Futures programme of research.

Simmie and Martin identify four distinct but overlapping conceptual frameworks for an evolutionary account of regional economic resilience: generalised Darwinism (which emphasises variety and selection); path dependence theory (historical continuity, lock-in and new path creation); complexity theory (self-organisation, bifurcations, adaptive growth); and panarchy (links resilience and adaptive cycles). They use the panarchy framework to develop a four-phase adaptive cycle of regional economic resilience, each phase (innovation and restructuring, growth, stability and rigidity, release) associated with different degrees of resilience.

In this context, transformability is the capacity of people to create a fundamentally new socio-ecological system when ecological, political, social or economic conditions make the existing situation untenable. The magnitude of change may be outside abilities to adapt, and may push a system to a threshold where the options are either system collapse or a managed transition to another stable state (Nelson, 2011). So the resilience approach can be 'how to persist through continuous development in the face of change and how to innovate and transform into new more desirable configurations' (Folke, 2006). A resilience framework might provide a perspective to understand how transformations take place and open up thinking on ways to radically reorganise systems to better meet our needs and goals. Options are expanded from considering how to improve wellbeing in the current situation to thinking about how thresholds may be navigated to develop desirable systems (Nelson et al., 2007; Nelson, 2011).

Disaster resilience

Much resilience-building is dominated by post-disaster emergency planning for sudden, large, turbulent events rather than gradual, small, cumulative changes (Davoudi et al., 2012). Planning for resilience following disaster draws on the range of interpretations outlined above, such as engineering resilience. For example, disaster resilience may be defined as 'an approach that deals with maintaining a balance and returning a system to its original state after a disturbance' (Deshkar, Hayashia, & Mori, 2011). 'In the case of urban systems [facing disasters], gaining resiliency means reduced levels of socio-economic loss with reduced investments in the recovery phase and faster reconstruction and greater chances of growth.'

In disaster studies, urban resilience has been interpreted as the capacity of a city to rebound from destruction with the focus on whether the city recovers, quantitatively, in its economy, population or built form (Davoudi et al., 2012). Recovery from shock is a theme in regional applications of the term, for example defining resilience 'as the ability of a region to anticipate, prepare for, respond to, and recover from a disturbance' (Simmie & Martin, 2010, citing Foster, 2007, p.14) or 'the ability of a region … to recover successfully from shocks to its economy that either throw it off its growth path or have the potential to throw it off its growth path' (Simmie & Martin, 2010, citing Hill et al., 2008, p.4).

The concept of "bouncing forward" is also found in disaster resilience.[3] Where disaster management includes risk mitigation, pre-disaster preparation, immediate post disaster response and longer term recovery, much resilience building occurs pre-disaster (whether that is a sudden event or one that happens over time).

Another interpretation of bouncing forward is the ability to use a disaster to reconfigure an urban system to one that is more likely to cope well with emerging future risks, such as climate change. For example: 'Christchurch can be the model for other NZ cities to change towards a more resilient

[3] From comments received from Anaru Waa, May 2013

model in order to withstand natural disasters, which will increase with the increased energy in the [atmosphere-ocean] system due to climate change.' (Howden-Chapman et al., 2011, p. 7)

Community resilience

Following literature on disaster resilience, Thornley et al. (Thornley, Ball, Signal, Lawson-Te Aho, & Rawson, 2013) define community resilience 'as the process of communities adapting positively to adversity or risk'. Aligned with some of the thinking above, they see resilience as a process, not an outcome, and view it as a capacity that grows out of people and communities rather than something that is imposed. They write that:

> The resilience of Māori communities incorporates Māori cultural processes such as whanaungatanga (sense of family connection) and manaakitanga (caring and hospitality), and is based on mana whenua status and whakapapa obligations.

Generally, there is no clear consensus as to what resilience means within literature on community resilience. Shea (2013) describes community resilience as a type of social-ecological resilience that contains elements of engineering resilience and explicitly includes interactions among ecological and human subsystems. The literature may emphasise community-based or bottom-up efforts in building resilience, and may discuss the capacities of communities to recover from disaster or adapt to change. Shea finds that much current work on community resilience draws on experiences from past disasters and on related work in the field of public health. These emphasise the importance of social relationships in promoting desired outcomes for communities, and draw on ideas of communicative planning and social capital (Shea, 2013). A further instance of the use of community resilience is cultural practices (Israel, Eng, Schulz, & et al., 2005) that, for example, help a migrant community to adapt to a new country or rural communities to adapt to urban life (Howden-Chapman et al., 2000).

Resilience at the urban scale

Definition or delimitation of the system under study and its boundaries and scale affect research and policy conclusions. Resilience incorporates broad scales; local responses can scale up and influence the overall resilience of a system (however the system is defined) and large-scale parameters such as markets and ecosystem resources can influence choices at local and individual level. If focusing on certain vulnerable structures, it is possible to overlook that the larger system may be quite resilient. (Nelson, 2011) Scale affects the identification of system variables and processes and influences perceptions about the desirability of system properties or configurations (Armitage et al., 2012).

Allan and Bryant (2011) review the literature on the resilience of the city, and in the fields of urban design and recovery planning. They adopt Walter and Salt's resilience attributes: diversity; modularity; tight feedbacks; innovation; overlap in governance; ecosystem services; social capital; and allowing for variability. These are general enough to be universally applied and specific enough to inform urban planning and design on a range of scales. Ahern (2011) discusses a proposed suite of strategies for building urban resilience: multi-functionality; redundancy and modularisation; biological and social diversity; multi-scale networks and connectivity; and adaptive planning and design. He also notes that if urban design is innovative in its pursuit of resilience, it has the potential to fail and this risk of failure can be reduced by piloting innovations as "safe-to-fail" experiments.

Issues

Issues with the concept of resilience include the pitfalls of applying a model from one disciplinary field to another, stretching the concept, or using it so commonly that it becomes a buzzword (Armitage et al., 2012; Davoudi et al., 2012; Simmie & Martin, 2010). While resilience is often portrayed as a "good" goal, it may not always be so. For example, Folke (2006) suggests it may be difficult to transform a resilient system from its current state to a different desired state. Moreover, as Scheffer and Westley (2007) have noted, systems may be inflexible or exhibit an apparent lack of resilience within certain bounds for good evolutionary reasons.

Defining a system's boundaries can lead to an exclusionary approach; analysis of resilience must determine the "resilience of what to what" (Davoudi in Davoudi et al., 2012). In studying community resilience, for instance, if administrative units are chosen as the boundaries, this may ignore important community boundaries within those borders as well as mask differences in the resilience of various communities (Shea, 2013).

A contribution of the resilience framework is the understanding that most socio-ecological systems can organise around a number of possible states. From an ecological perspective, there is no presumption that any state is more desirable than another, but in a social perspective people seek to manipulate systems on the basis of their knowledge and goals. The desirability of a given state is tied to normative judgements (Davoudi et al., 2012; Nelson et al., 2007). Resilience captures the notion of a dynamic state that can (with limitations) be measured or delimited. The system can deliver goods and services to people within the limits of the system, implying trade-offs between the goods and services that exist within different possible system arrangements. Values and goals ought in principle to be negotiated, although in practice they may be imposed. A resilience framework stresses the need to reflect on what societies value and desire for now and the future. (Beddoe et al., 2009; Nelson, 2011)

Multiple options are possible for a single (relatively resilient) system; some alternatives may provide similar services but with significantly different outcomes (for example in respect to poverty and security), implying there will be winners and losers (Nelson, 2011). This suggests questions of what is a desired outcome and resilience for whom. Resilience for some people and places may lead to the loss of resilience for others, raising the need to consider fairness in both procedures for decision-making and in the distribution of benefits and burdens, that is, the role of social justice. For example, if a social system gains resilience through diversity, and diversity requires redundancy, we can ask who pays now so that there is more resilience in future (Wilkinson in Davoudi et al., 2012), and whose knowledge and resilience is prioritised. In the Aotearoa/New Zealand context, there is scope for kaupapa Māori research into resilience (Thornley et al., 2013) and for considering the relationships between resilience definitions and frameworks and Māori worldviews, social institutions and experience of colonisation.[4]

An interesting exploration of such issues is that of Walker and Cooper, who situate the most recent trends in the application of the notion of resilience within the realm of neoliberal thinking about the modern, turbulent world of shifting transnational capital: '…what the resilience perspective demands is not so much progressive adaptation to a continually reinvented norm as permanent adaptability to extremes of turbulence.'(Walker and Cooper 2011, p.156) Shaw (in Davoudi et al., 2012) argues that embracing the politics is central to what the term has to offer, allowing values to be identified and choices made. Self-organisation in ecological systems can be mis-translated into self-reliance in social systems and so resilience used to advocate an unrealistic autonomy or the withdrawal of state support for vulnerable communities. Alternatively, resilience thinking can be

[4] Comments from Anaru Waa and John Ryks, May 2013

used to challenge power structures and accepted ways of thinking. It is increasingly linked to community-led initiatives such as Transition Towns or to de-commodifying and de-carbonising approaches to climate change. Developing sources of resilience and adaptive capacities may require challenging the status quo and so be considered a subversive undertaking (Nelson, 2011).

Sustainable cities

> …[resilience] should be seen in terms of bouncing forward, reacting to crises by changing to a new state that is more **sustainable** in the current environment. (Shaw in Davoudi et al., 2012, p. 309, emphasis added)

The Rio+20 framework for action includes a section on sustainable cities (see Appendix). While resilience is mentioned in that section as part of disaster risk reduction, the section also includes factors that bridge resilience and sustainability thinking, such as inclusive actions involving multiple stakeholders, equity in benefits, and emphasis on the consideration of environment and society together.

This paper is the opening to a discussion so, rather than a conclusion, it finishes with some thoughts from other authors which underline the links between resilience and sustainability:

> A resilience perspective provides a framework for evaluating actions and managing capacity for long-term sustainability. (Nelson, 2011, p. 115)

> Issues of management and sustainable use of urban landscapes require some kind of theoretical framework to set goals and evaluate results. Resilience theory is arguably one of the most suitable in urban environments because it allows integration of ecosystem function with social dynamics. (Andersson, 2006)

> …we can and should make our urban areas more resilient – resilient to, for instance, the economic and social adjustment that climate change policy and climate change itself will bring. There are strong, mutually reinforcing reasons for ensuring they become so. For example, instead of building more roads, which reduce resilience by further encouraging urban spread and fossil fuel use, we could reshape the roads we have, incorporating safe cycleways at the side and separating them from the roads by footpaths… Another strategy is to encourage greater density and diversity of land use at urban 'nodes'…thus saving on carbon dioxide emissions and reducing vulnerability to future oil scarcity. Such ideas are examples of the creative thinking that will be vital if we are to find workable solutions in the transition to a low-carbon, resilient society and economy. (Chapman & Howden-Chapman, 2010)

These ideas all suggest a strong area of overlap between resilience and sustainability. In practice, unless resilience is interpreted in the narrow sense of engineering resilience, a more resilient city is likely to be a more sustainable city. Resilience does not necessarily imply sustainability, and sustainability does not necessarily imply resilience, but a city that is both resilient and sustainable has a range of qualities that are desirable.

While resilience can emphasise a dynamic process of adaptation that a sustainable city would reasonably aspire to, sustainability emphasises the integration of a range of critical elements that support long-term quality of life. Resilience emphasises process, while sustainability emphasises goals. Both are aspirational. For the purposes of the Resilient Urban Futures programme, both are important concepts and they are strongly connected.

Appendix

Sustainable cities and human settlements

134. We recognize that, if well planned and developed including through integrated planning and management approaches, cities can promote economically, socially and environmentally sustainable societies. In this regard, we recognize the need for a holistic approach to urban development and human settlements that provides for affordable housing and infrastructure and prioritizes slum upgrading and urban regeneration. We commit to work towards improving the quality of human settlements, including the living and working conditions of both urban and rural dwellers in the context of poverty eradication so that all people have access to basic services, housing and mobility. We also recognize the need for conservation as appropriate of the natural and cultural heritage of human settlements, the revitalization of historic districts, and the rehabilitation of city centers.

135. We commit to promote an integrated approach to planning and building sustainable cities and urban settlements, including through supporting local authorities, increasing public awareness and enhancing participation of urban residents, including the poor, in decision making. We also commit to promote sustainable development policies that support inclusive housing and social services; a safe and healthy living environment for all, particularly children, youth, women, elderly and disabled; affordable and sustainable transport and energy; promotion, protection and restoration of safe and green urban spaces; safe and clean drinking water and sanitation; healthy air quality; generation of decent jobs; and improved urban planning and slum upgrading. We further support sustainable management of waste through the application of the 3Rs (reduce, reuse and recycle). We underline the importance of considering disaster risk reduction, resilience and climate risks in urban planning. We recognize the efforts of cities to balance development with rural regions.

136. We emphasize the importance of increasing the number of metropolitan regions, cities and towns that are implementing policies for sustainable urban planning and design in order to respond effectively to the expected growth of urban populations in coming decades. We note that sustainable urban planning benefits from the involvement of multiple stakeholders as well as from full use of information and sex-disaggregated data including on demographic trends, income distribution and informal settlements. We recognize the important role of municipal governments in setting a vision for sustainable cities, from the initiation of city planning through to revitalization of older cities and neighborhoods, including by adopting energy efficiency programmes in building management and developing sustainable locally-appropriate transport systems. We further recognize the importance of mixed-use planning and of encouraging non-motorized mobility, including by promoting pedestrian and cycling infrastructures.

137. We recognize that partnerships among cities and communities play an important role in promoting sustainable development. In this regard, we stress the need to strengthen existing cooperation mechanisms or platforms, partnership arrangements and other implementation tools to advance the coordinated implementation of the UN Habitat Agenda with active involvement of all relevant UN entities and with the overall aim of achieving sustainable urban development. We further recognize the continuing need for adequate and predictable financial contributions to the UN Habitat and Human Settlements Foundation so as to ensure timely, effective and concrete global implementation of the Habitat Agenda.

(Rio+20 United Nations Conference on Sustainable Development, 2012)

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