



Toward a Framework for Resilience Assessments: Working Across Cultures, Disciplines, and Scales in Aotearoa/New Zealand

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Resilience appears within diverse literatures across the physical and social sciences, pervades social, and ecological systems models and has been mobilized in the quest to change environmental practices at local and international levels. Yet common language is needed to enable cross-disciplinary conversations. We discuss a novel interdisciplinary process identifying shared terminology and developing a framework to facilitate the integration of physical and social science understandings of urban infrastructure and resilience in urban systems. Drawing on bicultural knowledge traditions unique to Aotearoa/New Zealand, we reflect on resilience as a system property having ecological, social, economic and technical dimensions that influence well-being and sustainability outcomes.

Keywords: resilience, multicultural, multidisciplinary, assessment frameworks, New Zealand

INTRODUCTION

The concept of resilience resonates across many disciplines, albeit with varied meanings. It is prominent within the physical, social, and health sciences literatures, pervades models linking social and ecological systems and has been mobilized to instigate changing environmental practices at individual and local through to national and international levels. The origins of the term can be traced to the 1970s with the idea of ecological equilibrium and implications of a return to a previously identified steady state (Cretney, 2014). The concept of multiple equilibria emerged around the same time (Holling, 1973) followed by the idea that ecological systems are able to absorb change rather than having a single point of static equilibrium. A further realization was that there are links between ecological and social resilience (Gunderson, 2000; Holling, 2001). This connection led to the development of multi-disciplinary ideas of socio-ecological resilience (Folke, 2006; Walker and Salt, 2012). Out of this work, the question becomes *resilience of what to what and for whom* (Carpenter et al., 2001)?

Asking this fundamental question across various domains has given rise to additional understandings of “resilience,” such as resilience to natural disasters like earthquakes, and community resilience to social and economic disruption. This latter conceptualization has political

implications if, for example, resilience is used to emphasize individual responsibility by shifting the burden of economic boom and bust cycles of free market economies to those who are governed by them (Joseph, 2013; Neocleous, 2013). The form community resilience takes may also depend on the community in question. For example, for indigenous communities, resilience may be defined as "...the means by which indigenous people make use of individual and community strengths to protect themselves against adverse health outcomes" (Penehira et al., 2014).

Hence, wide-ranging views of resilience can encompass definitions from neoliberal conspiracy to a mechanism for community engagement (see e.g., Cretney, 2014 and references therein). The breadth of these definitions of resilience present barriers to truly multidisciplinary approaches to the topic as each discipline may have its own definition and utilizes it in disciplinary-specific ways. In this paper, we consider the application of resilience through the lenses of physical, social and economic sciences to urban systems: people, place, culture, and services, using resilience assessment as a planning tool for urban sustainability. In particular, we reflect on the character of urban systems that enable "wellbeing" or, in other words, enable an urban system to respond to a challenge in a way that aids that system's continued survival.

The city is a dynamic and complex system, a view that places emphasis on interactions and connectivity and is reflected within the framework of the UN Sustainable Development (SDG) goals, which encourage a systems interactive approach, particularly SDG 11 (sustainable cities and communities) (Nilsson et al., 2016). The study of complex systems originated as a branch of (Western) physics. Its application to cities has become an established and widespread collaborative research endeavor that crosses disciplinary boundaries and reaches into both the sciences and humanities (Weinstock, 2013). Most of the application of the idea of a city as a complex system has been from a western perspective; there is little indigenous literature on the topic. We share the contention held by Broto and Allen (2012) that interdisciplinary dialogue is the key to developing new theoretical and practical approaches to understanding urban dynamics. The challenge, as they outline, is achieving a balance between reflecting the geographical and social complexity of cities, and developing practical interventions that may be usable in planning and urban design.

As residents of Aotearoa/New Zealand an important part of our deliberative process and development of a resilience framework was to recognize our Treaty of Waitangi and to acknowledge the inequitably negative impacts that urban living can have for Māori. As part of this dual recognition we have attempted to include Māori world-views within our conceptions of resilience and its role in how urban systems can contribute to well-being.

In response to the strategic aspiration for Aotearoa/New Zealand's cities to transition from a predominantly dispersed urban form to a more compact form, we are concerned with understanding the likely impacts of such a change from a range of disciplinary perspectives as well as from Māori and non-Māori cultural perspectives. To facilitate conversations

across disciplines and cultural perspectives we developed frameworks depicting the interdependencies of elements of an urban system, inclusive of those elements contributing to resiliency.

ASSESSING RESILIENCE

As noted above, the concept of resilience has multiple meanings that are often dependent on context and discipline. This multiplicity of meanings makes it challenging to apply resilience ideas in a complex system (Carpenter et al., 2005; Resilience Alliance, 2010; Quinlan et al., 2015). An important distinction between meanings is whether resilience has an objective existence, is purely conceptual or a function that has both qualitative and quantitative dimensions. This distinction has implications when trying to assess resilience: is it a "thing" that can be measured or a process that leads to outcomes, such as well-being. Similarly, well-being itself can be interpreted in different ways: is it, too, a tangible state or rather a capability that enables people to lead lives that they value? (Kearns and Andrews, 2010).

Assessments of resilience have often been qualitative (Resilience Alliance, 2010; Birkmann et al., 2012; Nemec et al., 2013; Quinlan et al., 2015) but significant effort has also been applied to developing and applying more objective assessment methods and metrics. Some authors describe developing multicriteria approaches to define a range of indicators for assessing resilience (Quinlan et al., 2015), Milman (2008) assigned scores to factors influencing resilience in urban water supply systems by using questionnaires to gather the views of water managers and Nemec et al. (2013) developed an expert-based method assigning scores to a set of ecological and social indicators for assessing watershed resilience to the effects of dam building.

Allen et al. (2005) described methods to assess the relative resilience of ecological and other systems based on discontinuities in the distribution of functions in a system. Nash et al. (2016) used these ideas to show how differences in cross-scale functionality affected the resilience of reef ecosystems to climate-induced disturbances. In another approach, Scheffer et al. (2009) described how changes in autocorrelation and variance of response variables can act as early warning indicators of a reduction in system resilience. However, Burthe et al. (2016) found both these variables to be poor predictors of system state and recommended investigating the utility of a wider suite of statistical indicators coupled with improved empirical understanding of system behavior. Although progress has been made in developing approaches for quantifying resilience, Angeler and Allen (2016) pointed out the need for new indicators and assessment methods that connect the many components of resilience. Quinlan et al. (2015) recommended that such methods be grounded in theory, aim to improve understanding of the system dynamics, and be context-specific. However, rather than a single theory, resilience has been seen to be a set of ideas about the interpretation of complex systems concerned with understanding a system's persistence in response to change (see e.g., Rotarangi and Stephenson, 2014 and references therein). Rotarangi and

Stephenson (2014) also point out that while much resilience thinking is about change and response to change, little thought is given to the stable parts of a system. They consequently introduce the concept of resilience pivots as the stable core values of a system about which adaptation and transformation take place; such as relationships to land and to community.

Many resilience issues cut across a range of disciplines and across scales from the individual to the city- or region-wide, although assessment is often siloed—different considerations are seen to “belong” to different communities of experts each with their own approach to assessing future scenarios (Allan and Bryant, 2011; Collier et al., 2013). For example, climate change and incidence of severe weather events have impacts on the natural environment, built environment, social and economic considerations, all interacting with each other. Therefore, adapting to a problem such as sea-level rise will require the expertise of physical, natural and social scientists, communities, planners, legislators, engineers, economists and others—all of whom will have a different view of the forces involved. For all interests to be reconciled, a shared understanding of the problem is required, including what it is that resilience is seen to help sustain. This idea of multiple viewpoints chimes with the SDG framework in which a systems analysis of positive and negative interactions can highlight the co-benefits of particular policies, a recognition also reflected in the need for collaboration across organizations and different scales in SDG 17 (Partnerships for the goals) (Howden-Chapman et al., 2017b; Nilsson et al., 2018).

CREATING AN AOTEAROA/NEW ZEALAND-BASED FRAMEWORK FOR RESILIENCE ASSESSMENTS

Urban New Zealand has a growing multicultural character, but the fabric of urban life remains centered on two principal cultural histories—Māori and European, largely British, or Pākehā in local vernacular. Many of our urban centers in Aotearoa/New Zealand have been established around or on what were originally Māori settlements. Colonization has meant that mana whenua (those who have traditional authority over a location) have lost much of their physical and social resources (Stuart and Thompson-Fawcett, 2010). Māori who have migrated to urban areas (mataawaka) have also faced many challenges. Over recent decades there has been a growing recognition of indigenous rights and obligations under Aotearoa/New Zealand’s founding document, the Treaty of Waitangi. There has also been a growing appreciation that mana whenua and mataawaka are a key part of what makes our urban environments unique internationally as well as being an important source of vibrancy that brings life to urban living (Ryks et al., 2014).

Cote and Nightingale (2012) raise the questions of resilience of what and for whom? According to their question we need to understand resilience as a property of “things.” These “things” need to be relevant to the Aotearoa/New Zealand urban context. We may understand these things in terms of scale, such as neighborhoods, communities and cities as a whole. Alternatively, we may consider them as social units; from a Māori perspective

these could be whanau, hapu, and iwi. The “things” may also be domains within and around urban areas such as social networks, built environments, natural environments or economies. It is not surprising when we consider the many things, and varying ways they can be expressed, that we end up with many different interpretations of resilience. In seeking to develop a city-wide understanding of resilience we must identify a common “thing” that reflects all the scales and domains that can exist within the urban environment.

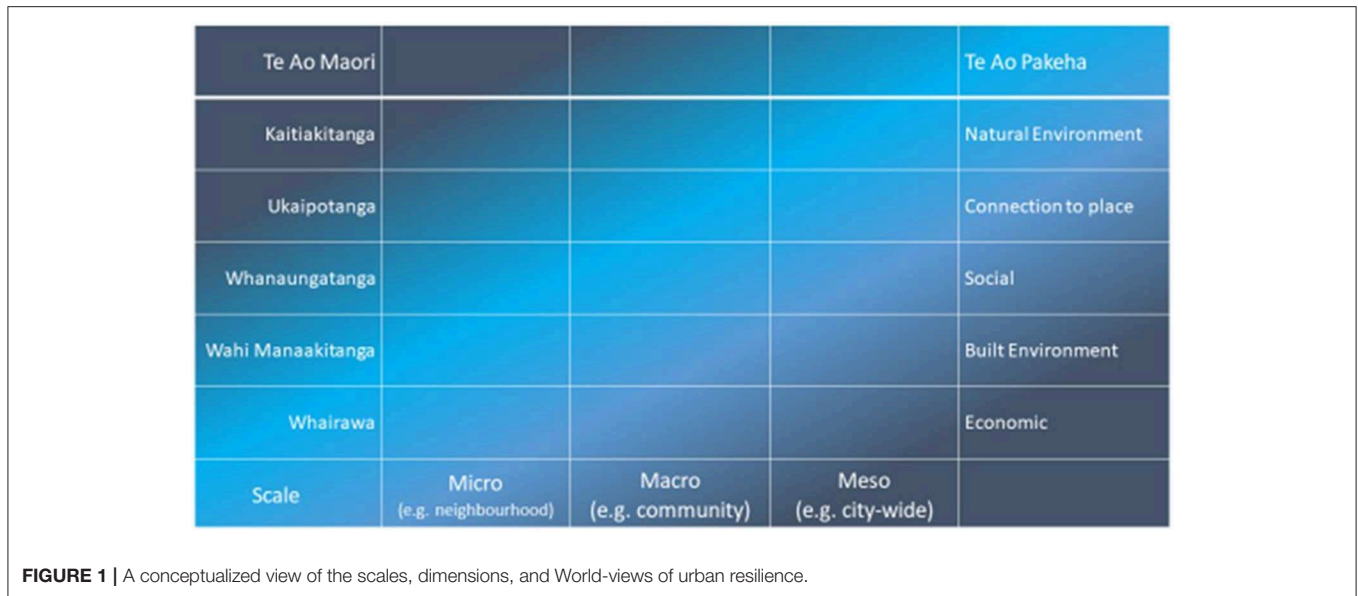
A key reason why we are interested in understanding the resilience properties of things in or linked to urban environments is that they affect our well-being. A failing fresh water system has direct impacts on health; housing policies can affect how we connect as communities, and transport infrastructure affects access to goods and services. In this paper we consider well-being to be the “thing” whose resilience ultimately concerns us. Well-being can be conceived in different ways (Fleuret and Atkinson, 2007; McLeod, 2017). As an outcome we may see it as good health, or experiences of pleasure (hedonism) or achieving deeper understandings about ourselves (eudaemonism). However, these definitions tend to have an individual focus. They also run the risk of essentialism, in that we risk defining well-being as a list of traits with the implication that those who do not hold these traits are unwell, regardless of whether or not those people subscribe to those traits. It is also difficult to see these conceptions of well-being as having resilient properties. After all it is not possible (and probably not healthy) to achieve these states all the time.

An alternate perspective sees well-being as a set of capabilities and functions (Sen, 1999). In this context, the goal of well-being is not to achieve some prescribed state, but rather that people are *able* to live lives that they have reason to value. What constitutes a valued life is, of course, subjective, and specific to people and communities. We are therefore interested in what capabilities enable people to be well and the ongoing experience of being well.

Figure 1 conceptualizes well-being domains from Māori and Pākehā perspectives. The domains in the left column are drawn from the Nga Pou Mauriora (NPM) model (Waa et al., 2017).

The domains on the right are the equivalents of the NPM but are also commonly referred to in the urban well-being literature. The NPM framework consolidates Māori and international literature on well-being (Durie, 1999; Love, 2004; Morgan, 2004; Te Puni Kokiri, 2007; MSD, 2010; Pohatu, 2011; Awatere et al., 2012). The overarching outcome is that our urban environments are able to sustain a way of life that Māori and Pākehā collectively have reason to value. “Whanaungatanga” highlights the importance of social support, whereby through shared experiences community members develop a sense of collective belonging, obligations and reciprocal caring. “Kaitiakitanga” acknowledges human dependence on the natural environment. Typically, those iwi and hapu who traditionally inhabited an urban area (mana whenua) play a primary role of kaitiaki (guardians of the natural environment).

However, all urban dwellers are obligated to serve as guardians to ensure sustainability of natural resources and in respect of mana whenua. “Ukaipotanga” is a metaphorical term that highlights the importance of urban environments in promoting a sense of Māori identity and belonging. Within Māori culture the



concept of manaaki is a core value based on the importance of providing hospitality, support and nurturing for guests as well as family and community members. “Wāhi Manaakitanga” extends the concept of manaaki and applies it to how urban governance acts to create communities that are healthy and safe places to live. “Whairawa” describes the accumulation, distribution and access to wealth and capital within Māori communities. This includes monetary wealth and assets, such as marae (meeting houses), environmental and social resources more broadly, and the processes through which resources are generated, protected and used to address the needs of communities.

The scales across which well-being can be considered are indicated along the bottom row. We contend that a comprehensive framework for resilience research should encompass all of these scales and domains to reflect a bicultural, yet integrated, systems view of New Zealand cities.

METHODS: FRAMEWORK DEVELOPMENT PROCESS

Here we report on an interdisciplinary process of identifying shared terminology and a systems framework to facilitate the integration of physical, social and health sciences with bi-cultural understandings of resilience in urban systems. Awareness of the need for cross-disciplinary dialogue arose during our involvement in a large multi-institutional, multi-disciplinary research programme investigating drivers of urban development in Aotearoa/New Zealand cities and the social, environmental and economic impacts of different forms of development (Early et al., 2015; Howden-Chapman et al., 2017a). It became clear that to undertake a comprehensive assessment of how urban change might influence resilience would require a structure that enables disciplines to work together across physical scales, social structures and world-views. We hypothesized that such

a structure is possible using a systematic approach to identify the common components in resilience assessment and reaching agreement on a common language.

The authors, a group of social, physical, and health scientists worked collaboratively (2015–2018) in a series of roundtable conversations to develop a single systems framework wherein a common resiliency lens could be applied that linked drivers of urban change to population well-being. Members of the group came from a range of disciplines (geography, hydrology, economics, Māori health, public health, and environmental science) and research fields (community formation; transport, energy and air quality; urban waterbodies). These disciplinary perspectives brought a range of assessment methods informed by the respective “culture” of each discipline.

The intention was to integrate the various disciplinary approaches to resilience assessment. Representatives of each discipline therefore constructed their own systems diagram or framework encompassing the most important processes and feedbacks that link urban change to well-being and sustainability. We then looked for commonalities in the diagrams to derive a simplified structure which uses a set of generic elements in the place of the detail provided in each team’s original diagrams. Four examples of the system diagrams devised by disciplinary groups are shown in **Figure 2** and demonstrate the approaches to the inter-relationship of resilience elements. The final concept for a systems framework encompassing elements of all the varied approaches to assessing resilience is shown in **Figure 3**.

Our framework takes the approach that the various drivers of urban development have direct influence on the character and properties of urban systems and hence the services that the system is able to provide. It places resilience as a property of the system which has a range of attributes. The rationale for having these system services is that they promote and protect the well-being of urban citizens. The ultimate “output” in this case is sustainable well-being. It is worth noting that a system that is not

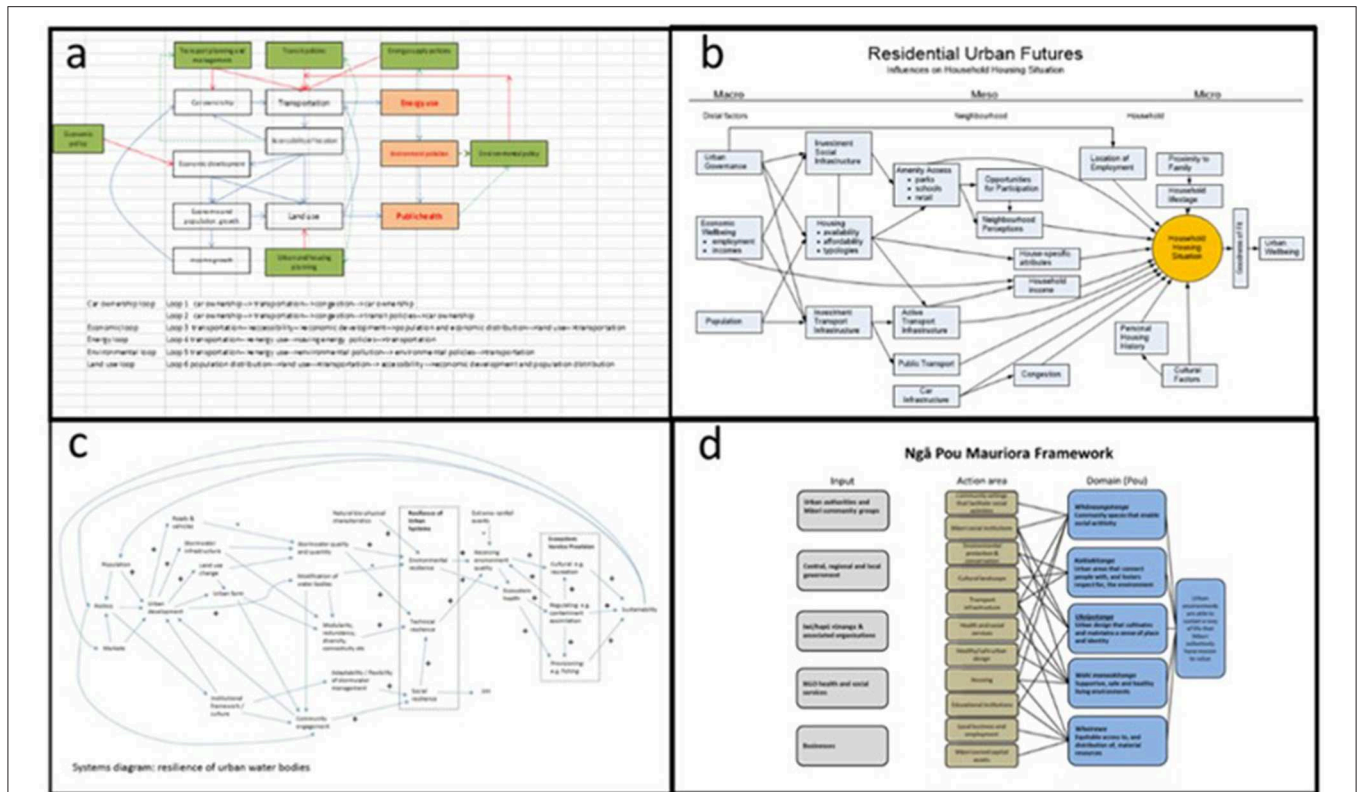


FIGURE 2 | Four examples of systems diagrams devised by members of the team to illustrate factors impacting resilience in **(a)** transport policy, **(b)** liveability, **(c)** urban water bodies, and **(d)** Maori communities.

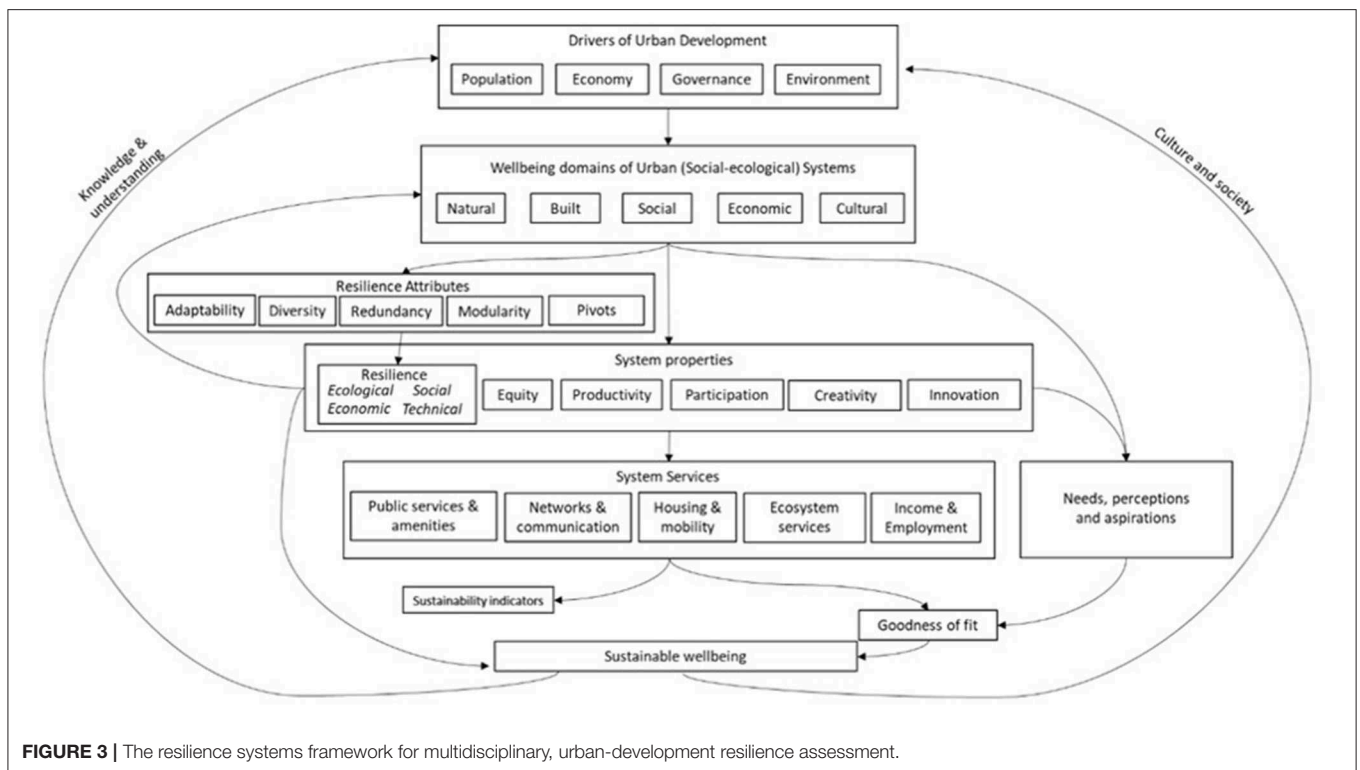


FIGURE 3 | The resilience systems framework for multidisciplinary, urban-development resilience assessment.

resilient could create well-being for a limited time, but in a way which is not sustainable.

The drivers of urban change—system disturbances—occur as effects arising from: changing population dynamics, economic circumstances, alternative governance models, and environmental influences. They act on the character of the urban system portrayed in terms of natural, built, social, economic and cultural environments. The character of the urban system features some degree of resilience, understood in terms of the extent of system properties: adaptability, diversity, modularity and redundancy. This resilience (understood in terms of the resilience of features of the system-to-system disturbances), emerges from the extent to which the elements of the character of the system display the resilience properties.

The properties and services included are not intended to be exhaustive but rather are indicative of elements that may be examined in more detail. Although not undertaken here, all of the individual boxes within the diagram could, in principle, be expanded with increasing levels of detail to follow any particular line of enquiry as in the case of fitting the “Resilience attributes” into the “Resilience” category of systems properties.

ASSESSMENT OF RESILIENCE ATTRIBUTES AND INDICATORS

To help in understanding how resilience attributes and system properties are linked we selected a range of resilience attributes identified in the literature (multifunctionality; redundancy; modularity; diversity; multi-scale networks and connectivity; overlaps in governance and “messy” institutions; tight feedbacks and adaptive planning and management) (Walker and Salt, 2006; Ahern, 2011; Rotarangi and Stephenson, 2014). We assessed how well they performed for discriminating between more and less resilient forms of urban service provision. We did this across four types of system service (“Kaitiakitanga”/Ecosystem Services; “Ukaipotanga”/Sense of community, place and identity; Mobility; Housing). If most of the attributes were agreed to work well across most services, then they were considered to constitute a useful contribution to a shared language, from which we can build an integrated approach for assessing resilience in urban systems.

At this stage we have simply mapped corresponding Māori and Pākehā concepts onto each other. To be truly bicultural, and to avoid simply using Western concepts to interpret what resilience means from a Māori perspective, we would need indicators drawn from Te Ao Māori (The Māori World). For example, much Māori resilience and well-being focusses on stable community institutions, with urban marae (tribal meeting places) as an exemplar, and with resilience pivots forming the stable core of the system.

A table of exemplars from our evaluation is supplied in **Table S1**. It is envisioned as a first step toward a tool for applying the ideas encapsulated in the systems diagram to perform resilience assessments so as to predict sustainability of different urban development scenarios. Table entries aim to describe how the attributes (rows) present in each of the system

services (columns) contribute to the resilience of an urban system to the pressures of urban development. For example, the way multifunctionality is incorporated into and provides benefits for Ecosystem Services is described as: *Greater multifunctionality supports the provision of a wider range of ecosystem services. Stormwater management devices such as wetlands, for instance, provide for contaminant removal and flood control (regulating services) and help to maintain the quality, ecology and amenity characteristics of downstream waterbodies (habitat, provisioning and cultural services).*

The framework described here allows qualitative descriptions of attributes or characteristics and the expected outcomes of changing attributes under different development scenarios. The intended outcomes are narratives as descriptors of change. The way this would be applied is that any given circumstance, e.g., a development, would be examined for each of the resilience attributes across the range of system services. Any development that qualitatively meets the descriptions in the table would be deemed to possess that resilience attribute. The more attributes it possesses, the greater its overall resilience is deemed to be. At this stage it is only an assessment of the current functionality of a system (in terms of its resilience attributes). How a system could or should change to deal with a disturbance to help the system services not only return to the status quo, but also to get better, is not dealt with. The way to improve well-being or liveability with this method would be to examine different development scenarios to explore, for example, how the attributes create a pathway for Sense of Community to deal with acute and chronic system disturbances. Ultimately, measurable indicators of resilience can be derived from these narratives (Quinlan et al., 2015) and environmental modeling of urban change has taken this approach (Coulson et al., 2017; Moores et al., 2017).

DISCUSSION

In light of the diversity of our disciplinary starting points, as collaborators we recognized the importance of maintaining a sustained dialogue. This paper traces the conceptual deliberations that emerged through the process. Engaging in this conversation required trust in the process, and an interdisciplinary curiosity given that, at least at the outset, our disciplinary backgrounds had us using different scientific dialects. Intermittent roundtable conversations required us to avoid being overly constrained by our own disciplinary languages and explore malleability in the key terms adopted. Reaching common understandings of key constructs such as resilience also left us engaging at a high level of abstraction. To ground the conversation, we found the need to return to the specifics of case studies of urban change to test the face validity of the concepts and definitions being employed.

As an example, we have created descriptive narratives of developments currently underway in Auckland by applying the concepts in **Table S1**. The full discussion is given in **Supplementary Material**. Four developments, three in Auckland and one in Wellington are considered. Long Bay is on the northern fringes of Auckland and planned for 2000 dwellings. Hobsonville Point is on the north western edge of Auckland

and planned for 3500 dwellings by 2024. Waimahia Inlet is a development planned for 295 dwellings in south Auckland. Te Aro Pā papakāinga is a small community led development in Wellington of 14 dwellings. The Hobsonville Point and Long Bay developments include schools, retail and commercial spaces along with recreational green spaces. Whilst Waimahia Inlet has green spaces, it and Te Aro Pā depend on proximity of local facilities.

Across the developments we consider whether the attributes (multifunctionality; redundancy; modularity; diversity; multi-scale networks and connectivity; overlaps in governance and “messy” institutions; tight feedbacks and adaptive planning and management) of the services (“Kaitiakitanga”/Ecosystem Services; “Ukaipotanga”/Sense of community, place and identity; Mobility; Housing) confer a level of sustainability or resilience.

Figure 3 describes the framework developed by our interdisciplinary team. The framework is intended as a product of its time located firmly in Aotearoa/New Zealand’s contemporary challenges for sustainable urban well-being. Amongst those challenges is enacting the partnership of indigenous Māori with successive migrations, each of diverse character (for example post Second World War from Europe, Māori from rural to urban settlements, and more recently globally-diverse in-migrations) to develop distinctive Aotearoa/New Zealand urban environments.

Our contribution to the literature lies in the combination of elements from Māori and Pākehā world views, following earlier attempts in relation to well-being (Kearns et al., 2006). A further aim has been to examine how Māori conceptions of resilience (Rotarangi and Stephenson, 2014; Lambert, 2015) apply within the urban environment. As noted earlier, an obvious disparity between usages of the term “resilience” is whether it is purely conceptual or has some objective, tangible form. In particular, we need to consider whether it is a thing that can be measured or is a process that enables people to live valued lives. However, our “working” view is that resilience is an attribute (i.e., a property) of other things or processes. It is more an emergent property of the system in question, whether that system is physical or cultural. Again, this portrayal of Māori considerations reflects an attempt to integrate Māori and Pākehā worldviews of resilience. It is likely this system depiction will evolve further as trial implementations are undertaken and the strengths and limitations emerge.

From a Māori perspective, one of the disturbances is the system itself as it has been imposed over pre-existing Maori systems. The introduction of resilience pivots enables the consideration of the core values of Maori communities to be included in assessing resilience to such a disturbance. Rotarangi and Stephenson (2014) identified core resilience pivots such as *whakapapa*, relationship to land, *whanaungatanga*, collective decision making for the good of all and *kaitiakitanga*, stewardship of the environment and the culture. These pivots provide stable points to ensure that cultural continuity is maintained in the face of change.

Sustainable well-being is an outcome of the goodness of fit between the needs, perceptions and aspirations of the urban residents and the configuration of the urban system’s properties.

This outcome arises to the degree to which the urban system can enable and sustain the inhabitants’ capacity to pursue the things they value (Sen, 1999).

The framework is a disequilibrium framework. Systemic change arises from the interaction between the external drivers of change and the needs, perceptions and aspirations of the citizenry. The ongoing change potential is expressed as contributors to the set of change drivers—the knowledge and understanding and character of the emergent civil society. At the heart of resilient urban futures for Aotearoa/New Zealand urban environments is the resilience of the capacity of people to pursue outcomes they value.

CONCLUSION

In conclusion, we share Amin’s (2014) view that social life in cities cannot be reducible to purely human dimensions; neither can infrastructure be considered in only material terms. Rather, the social and material are closely and symbolically interdependent dimensions of urban life. Resilience is a term that holds the potential to bring otherwise disparate researchers together around the same table with a common objective: to enhance our adaptive capacity. The challenge, as reflected in our deliberative process and the resulting innovative framework, is to begin to understand how to foster the development of effective resilience and help make adjustments in societies in order to ensure the effectiveness of resilience policies and strategies. In lieu of such thinking, we risk an ongoing siloing of responsibilities for the design, delivery and maintenance of component parts of urban systems, a situation that will continue to preclude a more integrative understanding of their interdependencies, above and below ground, and across urban professional disciplines.

Our paper has concerned itself with both a process (sustained interdisciplinary dialogue) and outcome (a hybrid framework that enables contributing researchers to assess outcomes of changes to the urban system in their own disciplinary domains). This novel framework permits development of a contemporaneous account of the influence of system disturbances on the features of interest to other disciplines. Full account can be made of the co-benefits and losses as policies for remediation or advancement of system outcomes are considered. Further work is needed in developing sustainability indicators and specific assessment tools, as well as a deeper exploration and integration of Māori resilience concepts. While provisional, our work offers a new basis for constructing value propositions for considering the dynamics of urban change and contributes to a locally-attuned and Aotearoa/New Zealand-based understanding of resilient urban futures.

AUTHOR CONTRIBUTIONS

All authors contributed equally to the conceptual development of this work by attending workshops led by PH-C and GC. All authors contributed text to the final article. GC co-ordinated the writing and editing.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/frsc.2020.00011/full#supplementary-material>

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