Pathways to Earthquake Resilience: Learning from past events

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Abstract

To be more prepared for future hazard events, learnings from past events must be identified, shared, and applied. This task does not belong solely to either practice or academia but requires a collaborative approach. In line with this goal, this special issue presents a combination of empirical research papers, research updates, and practice updates which contribute to knowledge of the impacts and outcomes of the M7.8 14th November 2016 Kaikōura earthquake in Aotearoa New Zealand, focusing particularly on lessons for the capital city of Wellington. The main focuses are how the event affected the thoughts and behaviours of Wellington residents; how organizations can improve their operation during disruptive events; and using collaborative, multi-sector approaches to identify how resilience can be understood and demonstrated. The title "Pathways to Earthquake Resilience" reflects the nature of the papers included in this special issue, bringing focus to the ways in which various sectors and disciplines can contribute to increasing resilience to earthquakes by implementing the lessons learned from past events.

Keywords: *Earthquake, resilience, research, practice, New Zealand*

Between 1998 and 2017, disasters globally killed 1.3 million people and negatively impacted another 4.4 billion; financial losses during this period amounted to US$2.9 trillion, not including the estimated 63% of unreported disaster impacts (Wallemacq & House, 2018). Earthquakes represented 8% of these global disasters but caused 23% of the reported economic loss and more fatalities than all other disasters combined (Wallemacq & House, 2018). The impact of earthquakes globally is increasing, with estimated annual financial losses increasing ten-fold and the number of people affected each year nearly tripling since the mid-1980s (United Nations Office for Disaster Risk Reduction; UNDRR, 2017).

To be better prepared to withstand, respond to, and recover from these events, it is crucial to learn from past ones. To learn a lesson, ways to improve in future must both be identified and implemented. Following the earthquakes in the Canterbury region of Aotearoa New Zealand (NZ) in 2010 and 2011, significant academic and policy learning has occurred, particularly around structural engineering, psycho-social well-being, indigenous disaster management, and organisational resilience. Knowledge of other earthquake risks, including in urban centres like the capital city of Wellington, are well established and a great deal of effort is going into building a more resilient city, including:

- The Wellington Regional Emergency Management Office's (WREMO) Group Plan (Wellington Regional Emergency Management Office, 2019);
- Updates to building legislation which target earthquake-prone buildings in Wellington (Smith, 2015);
- Wellington City Council's (2017) resilience strategy which is part of the international 100 Resilient Cities project (Berkowitz & Kramer, 2018); and
- Activities undertaken by the International Centre of Excellence in Community Resilience as part of the Integrated Research on Disaster Risk (IRDR) initiative (Doyle, Becker, Neely, Johnston, & Pepperell, 2015).

While Wellington has been affected by several strong earthquakes in living memory, such as the 2013 Cook Strait sequence, the impacts of the M7.8 2016 Kaikōura earthquake far exceeded previous experience. The shaking caused significant damage to buildings in

the central business district and triggered a tsunami warning. These impacts are still being felt and have led to a renewed urgency to strengthen the city's resilience for a future event.

The Kaikōura Earthquake

At 12.02 am on the 14th of November 2016, a complex series of fault ruptures occurred in the northern South Island of Aotearoa NZ, which led to intense, widely felt shaking (Blake, Johnston, Leonard, McLaren, & Becker, 2018). Two people were killed and nearly 600 injured and the earthquake generated an estimated NZ$1 billion in damage (Stevenson et al., 2017). The extreme and unusual shaking damaged several buildings in Wellington to the point of requiring demolition, despite the distance of approximately 220 kilometres between the city and the epicentre of the earthquake (Devlin, 2017). A tsunami warning led to many Wellington residents attempting to evacuate to high ground (Blake et al., 2018).

Wellington has a known seismic risk from a number of earthquake sources with the potential to generate severely damaging ground motions and tsunami hazards. Social science research focused on residents' preparedness suggests that the majority of the city is underprepared, even after extreme events like the Canterbury earthquake sequence (Colmar Brunton, 2018; Khan, Crozier, & Kennedy, 2012). Two of the papers within this special issue (McClure, Ferrick, Henrich, & Johnston, 2019; Vinnell, Milfont, & McClure, 2019) report how the Kaikōura event affected preparedness. With 80% of all NZ's future earthquake fatalities anticipated to occur in Wellington (Smith, 2015), increasing the resilience of the city is a vital task. Without the experience of a major earthquake disaster in recent years, it is important that Wellington identifies lessons from the Kaikōura earthquake.

The Kaikōura earthquake is considered one of the most complex geophysical earthquake sequences ever studied (Amos, 2017). Much work has been done to understand the science behind the complex rupture sequence (e.g., Hamling et al., 2017) as well as documenting and understanding the physical impacts. Social science research is also critical to improving our understanding of how people reacted to the event and how affected communities might identify and address their own strengths and weaknesses in preparing for future disruptive events. Much of this understanding about how individuals and groups responded may be transferable to other contexts as research efforts try to draw out tangible recommendations for other communities and cities at risk, nationally and internationally. This special issue presents a range of these insights from academic, practice, and collaborative perspectives, which are important not only for Wellington to improve its resilience but to assist other communities globally to identify their own pathways to resilience. The next section provides a short description of each of the papers in this special issue.

McClure et al. (2019) examined risk perceptions and preparation behaviour before and after the Kaikōura earthquake. In a similar project, Vinnell et al. (2019) examined whether the event affected both peoples' support for earthquake-strengthening legislation (mentioned above; Smith, 2015) and whether that support can be increased with targeted normative information. Kay, Brown et al. (2019) present lessons from businesses that experienced the 2010/2011 Canterbury earthquake sequence which can help those in Wellington, as well as other cities, to be better prepared for future events. Members of the same team, along with other colleagues, developed resilience indicators for Wellington (Kay, Stevenson et al., 2019) and modelled potential physical and societal impacts of a Wellington Fault earthquake (Brown, McDonald et al., 2019). Fleisher (2019) reports on his experiences as the Primary Local Controller for Wellington during the response to the Kaikōura earthquake. Brown, Campbell et al. (2019) describe the process and outcomes of a workshop in Wellington focused on establishing a shared understanding of community and cultural resilience across academia, practice, and government. Finally, Brown, Rovins, Orchiston, Feldmann-Jensen, and Johnston (2019) summarize a project assessing the disaster resilience of Wellington hotels which identified both strengths and areas for improvement.

Focus One: Social Impacts of the Kaikōura Earthquake

In this special issue, the findings from two surveys of Wellington residents are presented which demonstrate the impact of the Kaikōura earthquake on the way people think and act regarding earthquake risk in Wellington. McClure et al. (2019) found that participants perceived higher earthquake risk in Kaikōura after the November 2016 event than they had before; however, both Wellington and the rest of New Zealand were still perceived as being at higher risk of an earthquake than

Kaikōura. People in Wellington were more likely to prepare, particularly undertaking actions to help them survive after an earthquake (e.g., storing food and water), if they both perceived a higher risk to Wellington than other parts of NZ and believed that others like them were preparing.

McClure et al. (2019) used a common method from social science disaster research of retrospective self-report, asking participants after an event to recall their beliefs and behaviour from before that event. As future earthquakes cannot be predicted, being able to compare data collected before and after an event requires a partly-fortuitous alignment of research and nature. Vinnell et al. (2019) present findings of a *natural experiment* (Leatherdale, 2019). This type of methodology is used and valued internationally to understand the impacts of disasters, including recently the effects of the 2011 Great East Japan Earthquake (Oishi, Kohlbacher, & Choi, 2018). While relatively rare given the unpredictability of disaster events, these methods offer data which are better able to provide evidence of causal processes.

Vinnell et al. (2019) implemented the first part of their study in July 2016 (prior to the Kaikōura earthquake) and repeated the survey one month after the Kaikōura event. This study demonstrated that concern about and preparation for earthquakes did increase following the event. However, support for legislation to strengthen earthquake-prone buildings decreased after the earthquake; the authors suggest that the public saw less value in work to bring older buildings closer to the standard required for new buildings when it was relatively modern buildings that failed. Together, the work by McClure et al. (2019) and Vinnell et al. (2019) suggests that a post-event window exists during which there is an opportunity to leverage increased discussion and perception of earthquake risk into preparation. Doing so will improve the ability of individuals to survive, respond to, and recover from future potentially disastrous events.

Focus Two: Lessons for Organizations

Wellington represents a significant proportion of NZ's economic output as the region of the country with the highest gross domestic product (GDP) per capita ($71,622; Statistics New Zealand, 2019). Business continuity is therefore a critical factor in ensuring the city can recover quickly after a major event. Given the estimated cost of NZ$29 billion to repair the city after an earthquake similar to the Christchurch, 2011, event (Devlin, 2017), it is essential we work to improve business resilience and recovery.

Kay, Brown et al. (2019) present a research update describing the work of Resilient Organisations from the beginning of the extensive Canterbury earthquake sequence in 2010. Wellington's geography means that it will take weeks for some areas to receive all necessary outside support, compared to several days as was the case in Canterbury, leading to a different recovery trajectory (George, 2017). However, Kay, Brown et al. present recommendations that can help Wellington businesses and organizations prepare for and continue through the aftermath of a local earthquake, such as improving adaptive capacity by planning before an event and leveraging relationships. The ability of businesses to continue operating after a disaster is not unique to NZ; similar efforts to identify ways to increase resilience among organizations at both large and small-scales have been made in countries including Japan (Baba, Watanabe, Nagaishi, & Matsumoto, 2014) and the US (Marshall & Schrank, 2014).

One such group which can benefit from these lessons is the Wellington hotel sector; in the year ending February 2018, tourism contributed over NZ$2.5 billion to the city's economy (WellingtonNZ, 2018). Using a mixed methods approach of surveys, interviews, and secondary data, Brown, Rovins et al. (2019) describe the challenges and strengths for the hotel sector in Wellington that emerged during their response to the Kaikōura earthquake. Hotels tended to have strong social networks, financial preparation, and compliant buildings, but weaker external networks and a focus on planning for a narrow range of hazards. This work has recently informed an exploration of the disaster resilience of hotels across Europe (Ivkov et al., 2019). Such work contributes to research which has examined the resilience of the tourism sector generally, both in NZ (Orchiston & Higham, 2016; Orchiston, Prayag, & Brown, 2016) and internationally, including the US (Johnston et al., 2007) and Thailand (Biggs, Hall, & Stoeckl, 2011).

Focus Three: Current and Future Resilience

The Kaikōura earthquake drew out the strengths and weaknesses of emergency management groups in Wellington, without overwhelming those organizations.

This event therefore provided a rare opportunity to evaluate current resilience and to identify areas for improvement. Fleisher (2019) identifies how response efforts in Wellington were prioritized immediately following the earthquake; in particular restoring infrastructure (e.g., roads and electricity), managing the cordoning of areas of the central business district, and assessing approximately 80 damaged buildings. Despite the NZ$2-3 billion estimated cost in insurance losses and repair work, which is still ongoing, Wellington's key lifeline utilities were not seriously impacted. However, these infrastructures are highly vulnerable to a larger event in future and Fleisher recommends improving the resilience of systems such as electricity supplies. Learnings from an event which caused damage and disruption in Wellington but did not overwhelm systems are invaluable for improving the resilience of those systems.

Fleisher (2019) identifies important strengths and weaknesses in Wellington's response to the Kaikōura earthquake. For example, the infrastructure overall fared well. However, no faults proximal to Wellington were triggered in the Kaikōura earthquake so it is not necessarily clear what impacts a local rupture would have. To explore this, Brown, McDonald et al. (2019) use the knowledge found by research like Fleisher's as one part of a process to develop a model of impacts to infrastructure, the economy, and communities in Wellington in the event of a large earthquake on a local fault. Modelling is a primary and important tool to improve resilience; systems are best strengthened against shocks when the impacts of those shocks are understood.

In line with the work of Kay, Brown et al. (2019) and Brown, Rovins et al. (2019) examining the resilience of businesses and organizations, which are critical to the resilience of Wellington as a functioning city, Brown, McDonald et al. (2019) examine impacts on businesses as part of a larger system, forecasting future impacts to identify areas of infrastructure where resilience can and should be improved. This paper also goes further to include impacts on individuals and communities, considering outcomes including population displacement and behavioural adaptation. This inclusion of human elements in an economic model recognizes that resilience refers to more than physical infrastructure and economic systems.

Resilience as a concept applies at different scales, from societal to community to individual, and covers many different aspects of the composition and function of a city (e.g., Mamula-Seadon & McLean, 2015). To improve resilience, it is important to define the concept in regard to the specific context and goal of the efforts being made to build resilience (Hobfoll, Stevens, & Zalta, 2015). This is not a new argument, especially when considering research within a type of resilience, such as community resilience (Huggins, Peace, Hill, Johnston, & Muñiz, 2015; Kay, Stevenson et al., 2019). Within a specific type of resilience there are still challenges to reaching a shared understanding, including between researchers and practitioners (Huggins et al., 2015). Adding to these difficulties, resilience is examined and discussed at the level of individuals, communities, or societies, and as physical, social, or psychological in nature, among other distinctions (Kelman, 2018).

To address the challenges that arise when different groups work to different definitions of resilience, Brown, Campbell et al. (2019) brought together a group of academics, government officials, and private organizations to reach a shared understanding of what these forms of resilience mean. For example, workshop participants challenged the common reference to resilience as bouncing back to the state in which a system (e.g., community) existed before an event. Instead, participants agreed that lessons from the event should be incorporated into efforts to guide the community towards a new equilibrium, appropriate for a changed context, rather than necessarily returning to its previous state. Shared understandings like this are important in developing a common goal after a disaster, so that everyone involved in the recovery process is sharing knowledge and progressing together.

To progress along the pathway to resilience we need metaphorical stepping-stones: objective measurements of important component factors. Kay, Stevenson et al. (2019) used a collaborative and innovative approach combining top-down and bottom-up processes to develop resilience indicators for the Wellington Region, covering categories including social capital, disaster risk reduction action, and leadership quality and capacity. These indicators make more tangible the specifics of the shared goal of increasing resilience for which groups in NZ are individually and collectively aiming. Such work will help NZ to meet its goals as part of the new National Disaster Resilience Strategy as well as global mandates including the Sendai Framework for Disaster Risk Reduction (UNDRR, 2015).

Conclusion

This special issue focuses on Wellington resilience in light of the 2016 Kaikōura earthquake, including how the event affected Wellington residents' thoughts and behaviours and the operation of organizations. The articles within also consider what future resilience means for Wellington and how improvements might be made using collaborative, multi-sectoral approaches. Looking across social and organizational impacts and current and future resilience, the articles in this special issue present "Pathways to Earthquake Resilience", highlighting lessons identified from past events and suggesting ways in which these lessons can be applied across sectors and disciplines to continue increasing resilience.

Finally, the editorial team wish to thank the authors who have contributed to this special issue, the peer reviewers who gave their time to ensure the quality of the articles, to all participants of the research presented, and to our readers. We trust that this issue contains useful and useable insights for the diverse audience of the *Australasian Journal of Disaster and Trauma Studies*.

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