International Journal of Disaster Risk Reduction 16 (2016) 192–199

Contents lists available at ScienceDirect

International Journal of Disaster Risk Reduction

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

Are two earthquakes better than one? How earthquakes in two different regions affect risk judgments and preparation in three locations ☆

John McClure [a,*], Liv Henrich [a], David Johnston [b], Emma E.H. Doyle [b]

[a] Victoria University of Wellington, New Zealand
[b] GNS Science/Massey University, New Zealand

ARTICLE INFO

Article history:
Received 20 November 2015
Received in revised form
6 March 2016
Accepted 7 March 2016
Available online 10 March 2016

ABSTRACT

Research has shown that experiencing a single disaster influences people's risk judgments about the hazard, but few studies have studied how multiple disasters in different locations affect risk judgments. Following two earthquake sequences in two different regions (Christchurch, Cook Strait), this study examined earthquake risk judgments, non-fatalism and preparation in two New Zealand cities that were near to one of those sequences (Christchurch in Canterbury, Wellington near Cook Strait) and in one city that was distant from both events (Palmerston North). Judgments of earthquake likelihood were higher after the Cook Strait earthquakes than before in Christchurch and the rest of New Zealand, but not in Wellington, where the baseline risk was high. However, participants in all cities saw the risk as more real, plausible, and important after these earthquakes, particularly in Wellington. Preparations following the earthquakes were also higher in Wellington and Christchurch (where non-fatalism was highest) than in Palmerston North. Causal attributions for (not) preparing differed across the three cities, as did non-fatalism. These findings suggest that the Christchurch and Cook Strait earthquakes had a combined effect on citizens' perception of the risk, particularly in Wellington. Such events create a valuable window of opportunity for agencies wishing to enhance preparedness.

1. Introduction

In September 2010 and February 2011, earthquakes struck near Christchurch city in Canterbury, New Zealand, resulting in 185 fatalities and $40 billion in damage, over 20% of GDP (New Zealand Treasury 2013). Most New Zealand citizens had expected an earthquake near Wellington, which sits near several major faults, rather than Christchurch. Two years later in 2013, a series of earthquakes occurred in the Cook Strait (and Seddon near the Strait), near the city of Wellington. These earthquakes incurred no deaths but seriously damaged a number of buildings and gave Wellington citizens a taste of major shaking that many had not experienced before. What effect did these two series of events following in quick succession have on New Zealanders' judgments of earthquake risk and their preparation?

1.1. Risk judgments about natural disasters

Citizens' risk judgments are not sufficient to get them to prepare, but recognition of the risk is a prerequisite to preparation [21]. Few people prepare if they think there is no likelihood of an earthquake. People often discount low frequency events like earthquakes and fail to prepare for them while prioritising risks from more frequent events that may have minor consequences [38]. In addition, people often hold unrealistic optimism and see themselves as less at risk from hazards than others [35]. This bias occurs with natural hazards such as hurricanes and tornados [33,45], and earthquakes [4,12,26,40]. This optimistic bias is highest for rare events such as earthquakes [8] and is resistant to change [47].

Risk judgments and optimism are influenced by experiencing a hazard, although such effects depend on other factors. Where

☆This research was part-funded by an Earthquake Commission (EQC) grant to John McClure and David Johnston and a Foundation of Research Science and Technology (FRST) subcontract to GNS Science: CO5 × 0402. EEHD is supported by co-funding from EQC, GNS Science, and Massey University 2014-2016. We thank Bede Dwyer of EQC for information on EQC claims in different locations and Garth Fletcher for on statistical advice. Correspondence should be addressed to John McClure, School of Psychology, Victoria University of Wellington, PO Box 600, Wellington, New Zealand.
* Corresponding author.
E-mail address: john.mcclure@vuw.ac.nz (J. McClure).

http://dx.doi.org/10.1016/j.ijdrr.2016.03.003

people suffer damage from hazards, they elevate the risk from that hazard and are less optimistic [18,21,48]. Experience of a hazard makes the risk more available in citizens' thinking [46], and people directly exposed to hazards see the risk as higher than people who are distant from the events [50]. However, when people suffer no ill effects from a hazard event, the opposite effect occurs where they show a 'normalisation bias' and discount the risk of that hazard [15,26,27].

Judgments of the risk from hazards also reflect baseline probabilities and expectancies; if people expect a hazard before it occurs, their judgment of the likelihood of that hazard may not increase when they experience it [1,16,23]. McClure et al. [24] showed that when an earthquake happens in an unexpected place (as in Christchurch in 2011), the event has different effects on risk judgments in different locations. In their recall of the earthquake likelihood *before* the Christchurch earthquakes,[1] participants judged an earthquake more likely in Wellington, where an earthquake was expected but did not occur, than in Christchurch, where an earthquake was not expected but did occur. These judgments show the effects of expectancies, as Wellington has a history of damaging earthquakes (notably in 1848, 1855 and 1942) and scientists have long predicted more earthquakes there [19]. In contrast, *after* the Christchurch earthquakes, participants saw a future earthquake as equally likely in Christchurch and Wellington, showing that the experience of a disaster in an unexpected location (Christchurch) sharpens judgments of risk. Thus participants' base rate expectancy of an earthquake was previously higher for Wellington [5,6], but increased in Christchurch after the Christchurch earthquakes.

1.2. The effect of multiple events on risk judgments and preparation

Much research on risk judgments following natural disasters has examined the effects of experiencing a single disaster on judgments of the risk from that hazard [4,11,12,20,36,45]. Some studies have shown the effects of multiple tornadoes, but these were all in the same region (see [50]). Research in other domains suggests that multiple events augment risk judgments more than a single event [37]. However, few studies have studied the effects of multiple hazards in different locations on citizens' judgments of the risk from those hazards.

One exception that has studied the effect of multiple hazard events is Russell et al. [32], who examined preparedness before and after the 1987 Whittier Narrows earthquake near Los Angeles and the 1989 Loma Prieta earthquake near San Francisco. Russell et al. [32] found that preparation increased over this period. In addition, mitigation actions increased after the earthquakes, especially in San Francisco, which experienced the damaging Loma Prieta earthquake. The study did not examine changes in citizens' perception of the likelihood of earthquakes, although it did show that having frequent thoughts about earthquakes predicted more preparation. A second study focusing on multiple events in different locations examined citizens' risk judgments about tornadoes, which are more common than damaging earthquakes [48]. The study compared risk judgments and optimism in three towns recently struck by tornadoes with two control towns in states with similar tornado frequencies that were not struck by these tornadoes. Optimistic risk judgments were lower in impact towns than in control towns, yet they did not completely subside.

A similar sequence of events to those studied by Russell et al. [32] recently occurred in New Zealand. The 2010-2011 Christchurch earthquakes caused 185 deaths and $40 billion in damage. Two years later, a second series of earthquakes occurred in July and August 2013 in Cook Strait and Seddon, both close to Wellington (50 km and 80 km respectively). Wellington is the third largest city in New Zealand (population 300,000) and a major earthquake has long been expected there, due to its proximity to multiple faults.

Although no deaths resulted from the 2013 Cook Strait earthquakes, these events were widely felt as strong shaking in Wellington and a number of buildings were damaged [14]. Maximum peak ground acceleration (PGA) in Wellington City was 0.2 g for the July earthquake (Cook Strait) and 0.26 g for the August one (Seddon), making these earthquakes the most severe in Wellington since 1977 [10,14]. There were also a significant number of EQC (Earthquake Commission) insurance claims; these were concentrated in Wellington more than cities further from the earthquakes. For example, for the 21 July 2013 earthquake, there were 1863 EQC claims in Wellington, 80 in Palmerston North and 37 in Christchurch (Bede Dwyer, EQC). There were similar proportions of claims for the August event.

1.3. The present study

Most Wellington citizens were very aware of the earlier Christchurch earthquakes and had friends or relatives in that region [24], but they did not directly experience these events. In contrast, they did feel strong shaking from the Cook Strait events. The question we examined here is what effect these two sets of events (Christchurch and Cook Strait earthquakes) had on citizens' judgments of the likelihood of earthquakes and preparation in three cities: Wellington, whose citizens did not directly experience the Christchurch earthquakes but who did feel strong shaking from the Cook Strait earthquakes; Christchurch, where the major earthquakes occurred in 2010–2011 but was further from the Cook Strait earthquakes (approx. 300 km); and Palmerston North, which did not directly feel either series of earthquakes and where citizens had a lower expectancy of a future earthquake [31]. Palmerston North thus served as a comparison group for the two more directly affected locations (Wellington and Christchurch), similar to Weinstein et al.'s [48] study.

Thus a key issue we examined here is: How did people respond after the two major earthquake sequences in Christchurch and Cook Strait, which is closer to Wellington? We expected that these two events would affect people in Wellington more than Christchurch, because Christchurch citizens had directly experienced major earthquakes just two years earlier, and could be expected to judge earthquakes equally likely before and after the Cook Strait earthquakes and to prepare more before the Cook Strait earthquakes. In contrast, Wellington citizens were directly exposed to the strong shaking from the Cook Strait earthquakes only two years after they had seen the major effects of the earthquakes in Christchurch. So Wellington citizens had the combined experience of the vicarious knowledge of the Christchurch earthquakes and the direct experience of the Cook Strait earthquakes. We anticipated that these two events would act as a sharp wake up call to Wellington citizens who did not recognise the risk or prepare after the Christchurch events.

For risk measures, we assessed judgments of earthquake likelihood for different regions and added two new measures assessing judgments that the risk is more real, plausible and important since the Cook Strait earthquakes. We thought that these new measures would be less vulnerable than the likelihood measures to hindsight bias, where recall judgments are coloured by subsequent events [9]. New Zealand citizens expected an earthquake in Wellington prior to these two earthquake sequences [1,24], so we expected any 'wake-up' effect after the Cook Strait events to

[1] Of the two earthquakes in the province of Canterbury in 2010 and 2011, only the 2011 earthquake was directly in Christchurch, but we refer in this paper to 'the Christchurch earthquakes' to prevent confusion from using multiple place names.