Planning for Loss or Complexity?

New Zealand's Earthquake Commission: The Story So Far

The New Zealand Earthquake Commission (EQC), the New Zealand public scheme to provide insurance cover against geological hazards, working in close cooperation with the private sector, had to face between 2010 and 2011 one of the biggest challenges for a catastrophe scheme: the Canterbury earthquake sequence. This article explains in detail the mishaps experienced by the EQC in dealing with this crisis, how the whole system had to quickly adapt to manage a catastrophe of a, until then, unimaginable scale and presents the lessons learned six years later.

Hugh Cowan – General Manager, Reinsurance, Research and Education, Earthquake Commission
Bryan Dunne – General Manager, Strategy and Transformation, Earthquake Commission
Anna Griffiths – Senior Communications Advisor, Reinsurance, Research and Education, Earthquake Commission

1. Introduction

It is six years since New Zealand experienced its first 'urban' earthquake in more than six decades - a magnitude 7.1 earthquake near Christchurch in the Canterbury region of the South Island. That earthquake, in the early hours of 4 September 2010, was a prelude to repeated shocks with far worse to come. By the end of the following year the Canterbury earthquake sequence, as those shocks came to be known, had become New Zealand's costliest disaster on record. With 185 fatalities – all occurring on 22 February 2011 – and NZ$40 billion in economic losses overall (affecting housing, commercial property and infrastructure), the Canterbury earthquakes are now etched into the national collective memory.

Seismic activity will likely remain above previous historical levels in the region for decades, but the recovery and reconstruction effort has already incorporated experience that will guarantee greater resilience to future events should they occur. Public awareness of seismic risk has been revived and further improvements to hazard risk management seem likely. As bad as they were, the losses could have been much worse. In particular, the foreign capital available to New Zealand following the disaster attests to the power of insurance for economic and social recovery. The losses comprised 20% of national GDP, 80% of which was insured.

Paradoxically, the recovery also has been associated with unparalleled technical complexity, requiring intensive scientific, engineering and legal analysis, and a level of community engagement for which existing 'business-as-usual' arrangements have often been found wanting. Frustrations arising from the sheer scale of demand and the need to adapt organisational culture and service deliveries have, understandably, eclipsed acknowledgment of national benefits and the sustained Government commitment to recovery made possible by New Zealand's unique risk pooling arrangements.

In this article we introduce the New Zealand Earthquake Commission (EQC) and describe salient features of the Commission's role in hazard risk management and the various roles it has been called upon to perform in the Canterbury recovery. Drawing largely from published information, we explore the context of some topical themes, which we hope will provide useful insights into the strengths and limitations of our experience.

2. Earthquakes in Canterbury

Earthquakes and volcanoes have shaped the mythology and history of New Zealand since its islands were first settled by Mãori migrating from Polynesia in the 13th century. There is land above sea-level here because of the relative convergence between the Australian and Pacific tectonic plates, which gives rise to mountains and in the North Island, locally volcanic activity. Small earthquakes are frequently felt, but the past six decades have been relatively quiet with no earthquakes seriously affecting large towns or cities. The Canterbury region experienced damaging earthquakes in the 19th century and early 20th century. However, the main town, Christchurch is located on a wide floodplain at the edge of the plate boundary zone, where tectonic movements are less frequent and the surface expression of geological faults is masked by sediments transported from the Southern Alps. In those early days of European settlement, Christchurch occupied a fraction of its current area and there was little development on land since shown to be highly vulnerable to shaking.

Figure 1: A unique feature of the Canterbury earthquake sequence was locally dramatic settlement of the ground where saturated sandy soils liquefied, expelling large volumes of water and sediment. Underground pipe networks and buildings on shallow foundations were damaged in some cases beyond economic repair. The worst affected areas were considered unsuitable for reconstruction and the Government purchased many residential properties at pre-earthquake market valuation.
Source: Tonkin + Taylor.

The 4 September 2010 earthquake was of magnitude 7.1 with an epicentre near Darfield, a small town 40km west of Christchurch's CBD. It was followed by four other, smaller but locally more damaging shallow earthquakes, beneath Christchurch City and close-by – the first that year on 26 December and the rest in 2011 (22 February, 13 June and 23 December). The February 2011 event was the most devastating, resulting in the loss of 185 lives as a result of building collapses in the central city – 115 of which occurred in one multi-storey building (Cooper et al., 2012) – and rock fall in the Port Hills suburbs.

The Canterbury earthquake sequence was the first to seriously affect an urban centre since earthquakes had repeatedly struck New Zealand from 1929-1942, prompting the introduction of the first national building code in 1935 followed by the establishment of a state-backed insurance scheme for earthquake and war damages in 1945. That period of activity also contributed to the emergence of a research culture at Government laboratories and universities and led to widely emulated engineering practices in seismic isolation and capacity design (Park and Paulay, 1975; Skinner et al., 1993).

During decades of relative inactivity preceding 2010, the number of urban dwellers increased and with that a dependency on networked services. Fewer residents or community leaders could recall personal experience of loss to natural hazards. Competitive forces in commerce and restructuring in the public sector during the 1980s and 1990s (Scott, 1996; SSC, 1998) made accountabilities for managing natural hazard risk more explicit, but also increasingly complex in terms of coordination, data and information sharing. Over the same period, expectations of sustainable development were introduced to planning regulations with long-term resilience to natural hazards becoming a significant determinant of policy at community level (CAENZ, 2004). However, Government commanded proportionally fewer resources directly with which to respond to, or recover from, an emergency (Lee, 2010).

The effect of the Canterbury earthquakes has been far reaching. The recovery process itself has revealed one of the most unusual insurance events ever encountered. The natural catastrophe losses of 2010-2011 were notable, with earthquakes and tsunami in Chile and Japan, and flood events in Australia and Thailand. The compounding effect for

Australian and New Zealand hazard events meant that a region traditionally known for its mature insurance market and welcome risk diversification (yet contributing less than 3% to global non-life premiums) suddenly produced 20% of global losses (Munich Re, 2011). With the aggregation of losses that year among other non-peak risk zones, the term 'de-worse-ification' entered popular use for the first time.

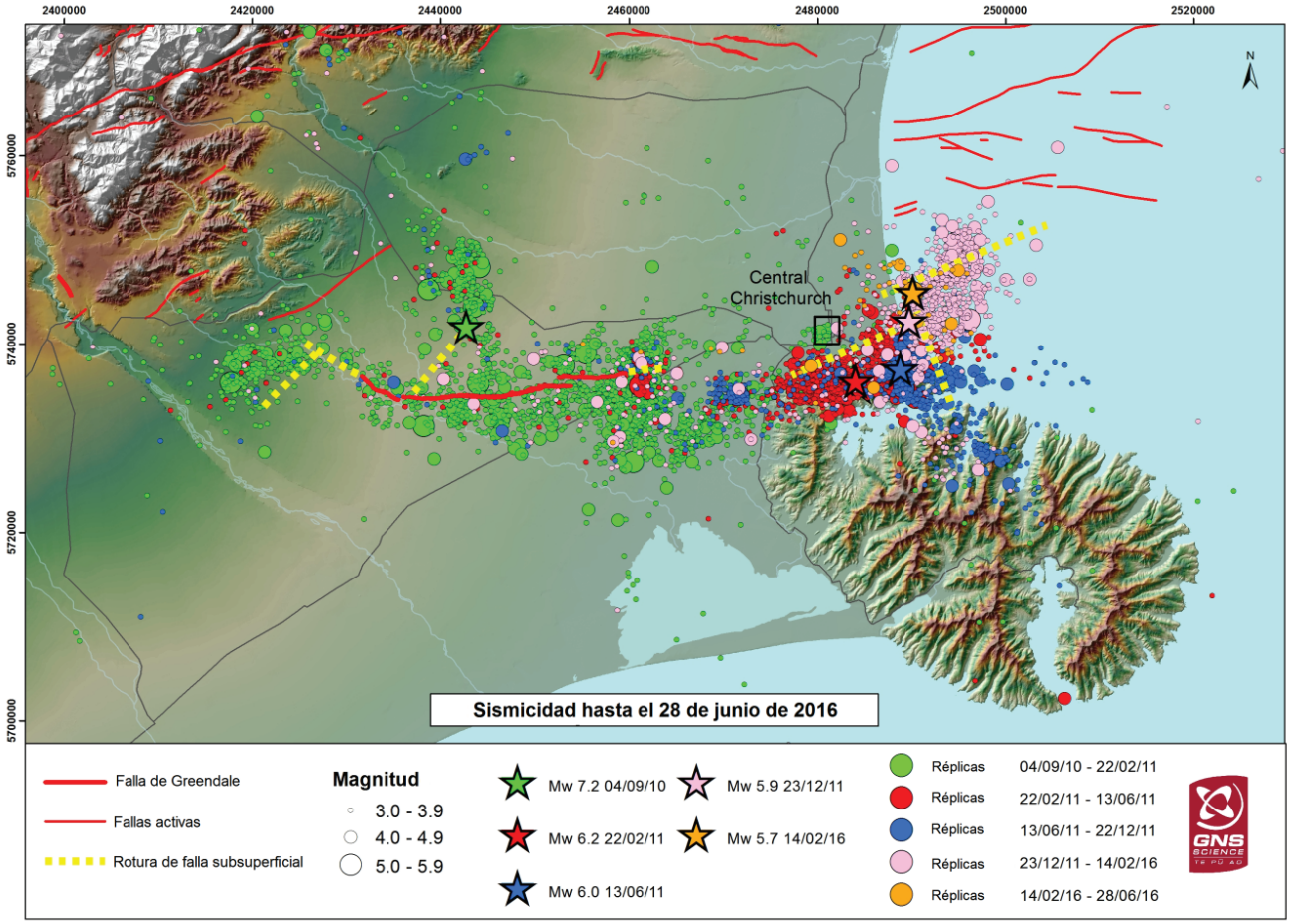

Figure 2: Multiple shallow earthquakes and sequential movement on a network of previously unidentified faults severely damaged the city of Christchurch (population 400,000) and surrounding areas between September 2010 and December 2011. While after-shocks continue to be felt periodically the built environment is now more resilient as a result of land zoning and rebuild practices. Source: R. Langridge and W.F. Ries, GNS Science.

3. Establishment and history of EQC

As noted above the Earthquake and War Damages Commission was established following the seismically active period of 1929-42 and in particular, in response to the excessively slow economic recovery of communities affected by the twin earthquakes in the Wairarapa region, north-east of Wellington, in 1942. There had been little insurance cover for earthquakes and wartime meant that damage had remained unrepaired for longer.

During the war, the Government had set up a war damage fund to provide reparation for damage to civilian property caused by defence activity. With the war coming to an end, this unused fund was used to start a new insurance scheme that would protect all physical assets in New Zealand against earthquake damage and ensure faster rebuilding and repair than had previously been managed. The scheme was similar to the example Spain had set with its *Consorcio de Compensacion de Seguros* which would administer Civil War reparations and then natural disaster damage.

3.1. How EQC cover works

A scheme like EQC eliminates the risk and uncertainty that would otherwise exist for homeowners, insurers and governments. It means homeowners do not have to rely on ad hoc government assistance following a natural disaster. Instead they have the certainty of a legislated right to catastrophe insurance with pre-established terms, backed by a Government funding guarantee.

Figure 3: Slow recovery and reconstruction in towns damaged by earthquakes near Wellington in 1942 led to the introduction of an affordable, compulsory earthquake insurance scheme, the forerunner to the Earthquake Commission. Ref: 1/2-123912-G. Alexander Turnbull Library, Wellington, New Zealand.

EQC insurance cover costs 15 cents + Goods and Services Tax (GST) for every $100 of private home or contents fire insurance. EQC revenue is collected by each homeowner's private insurer and passed on to EQC. Before the cost was tripled from five cents in 2012 it had been essentially unchanged, per dollar of cover, since the scheme's inception in 1945. The maximum annual premium payment for one home and its contents is $180 + GST. This gives the maximum cover of $100,000 + GST for the home, $20,000 + GST for contents and the value based cap amount of the residential land.

Over time EQC's cover has expanded to include other perils, the cover for war damage has been dropped (reflected in the organisation's name being shortened to the Earthquake Commission) and the insurance cover limited to residential property.

3.2. High insurance penetration rates

EQC insures about 90% of New Zealand homes against damage caused by earthquake, volcanic eruption, tsunami, landslide, or hydrothermal activity (including fire following any of these). Any other property insurance (commercial, industrial and agricultural property) is provided by private insurers. Those who do not buy private sector insurance do not receive EQC cover. All residential property owners who buy house and contents insurance automatically acquire EQC insurance cover and in this way, EQC's revenue is collected and passed on to EQC by each homeowner's private insurer. These arrangements contribute to New Zealand's extensive take-up of insurance which is second only to the Netherlands at 5.2% of GDP (Lloyds, 2012).

Historically, residential property has been a mainstay of the New Zealand economy. Not subject to capital gains taxation, housing, home ownership and equity withdrawal has been the principal means by which New Zealanders save for retirement or fund new businesses. This together with bank lending against housing has ensured a high level of insurance protection, and EQC's flat-rate pricing structure has helped to keep insurance premiums more affordable than they would be otherwise.

4. EQC and hazard risk management

Effective hazard risk management requires a 'systems-approach' that addresses all the factors that influence a society's vulnerability. Although the need for integrated hazard risk management is widely recognised, there are still large gaps between theory and practice, and wide disparity between levels of awareness, understanding and sustained action by agencies, professionals, and communities.

In an integrated system, no single group or organisation can address every aspect of hazard risk management, which is likely to be complex with large uncertainties and demanding an orchestrated and adaptive response(1). There is, however, significant value derived from groups or organisations (like EQC) with broad oversight of the system components, and the ability to support targeted interventions across institutional boundaries.

Efficient hazard risk management requires that treatment options are properly understood. *Avoidance* of exposure may be achieved through land use planning; *Control* of impacts through engineering design; *Transfer* of potential financial loss to insurance or alternative capital markets; *Acceptance* of risk may be agreed through adaptive capacity. All of this presumes awareness of the associated trade-offs including costs and benefits, and who pays and when. Optimising risk management outcomes requires not only technical understanding of risks, engineering and capital markets, but clear appreciation of accountabilities and the social and political processes that govern priority setting.

EQC's statutory functions place it at both ends of the risk management process. At one end, by financing risks which arise from geological hazards and the delivery of insurance for residential recovery in a disaster, and at the other end, by supporting research and education about natural disaster damage and its mitigation.

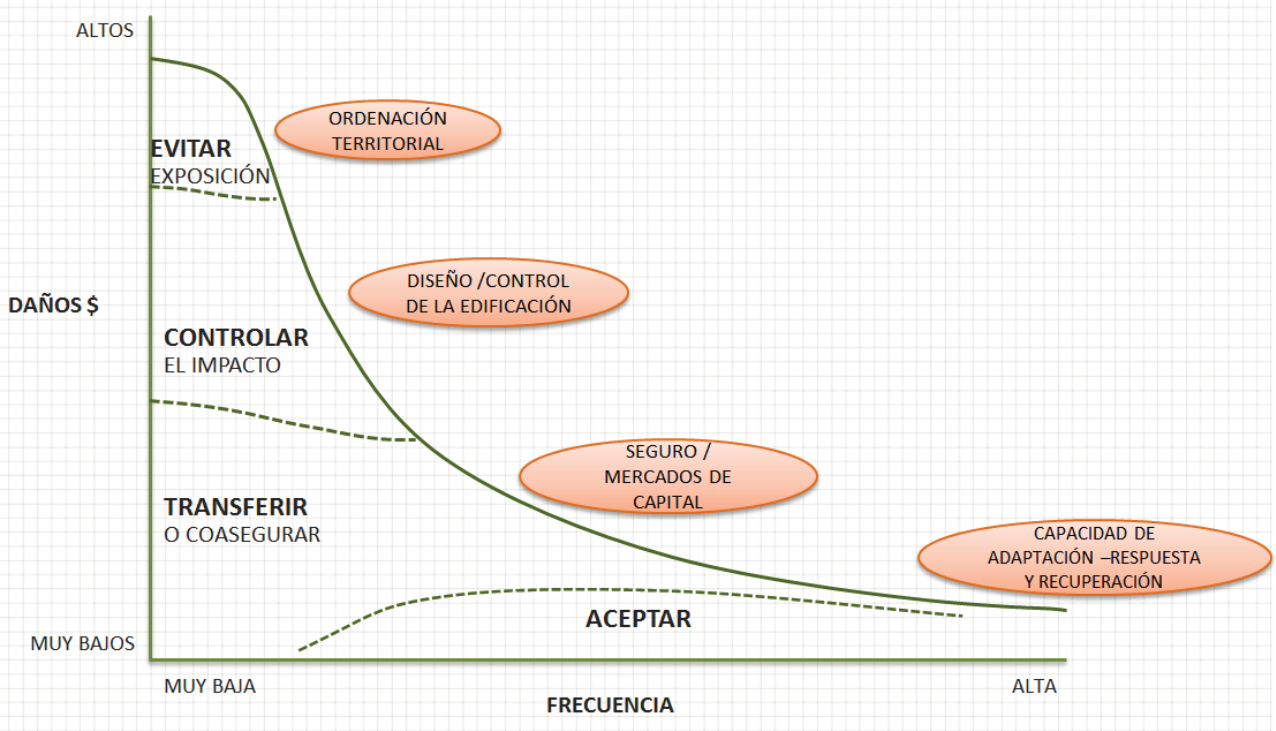

Figure 4: Effective risk management requires realistic assessment of the hazard and a balancing of the benefits and costs of treatment. The chosen approach will be influenced by the quality of available information, but ultimately will reflect accountabilities and expectations for societal or institutional outcomes, and the transparency of governance arrangements. How costs are to be spread over time and among whom, are implicit to all such choices. Adapted from Cowan, 2016.

(1) EQC's research and education contributions (and its other roles) need to be considered in the context of New Zealand's total effort in disaster risk management. Under current structures and arrangements there is significant devolution of responsibility for hazard risk management from central government to local government. The dominant theme is an all-hazards approach to risk management with dispersed accountability and coordinated action required across all agencies of government and at-risk communities.

4.1. Financial arrangements

EQC *transfers* the financial risk posed by New Zealand's natural hazard through financial arrangements. These include:

- The Natural Disaster Fund – an accumulated reserve whose structure and asset allocation strategy (New Zealand government stock, bonds and global equities) are agreed between the EQC Board and the Minister of Finance. The fund totalled $5.9 billion at the time of the Canterbury earthquakes and has since been depleted.

- A reinsurance programme – with a small population concentrated in a handful of main centres, the risk posed by a major event to our economy is significant. For this reason, EQC buys its reinsurance abroad. Each year, this is renewed. The premiums we pay are based on an understanding of the potential frequency or severity of an event, plus a loading that reflects uncertainty. Fortunately EQC's investment in research and good quality data about hazards reduces the guesswork associated with calculating risk, thereby reducing the prices we might otherwise pay. In 2015-16, EQC continued to negotiate consistent reinsurance coverage with no erosion of terms or conditions, despite the impact of the Canterbury earthquake sequence.

- A backstop Government guarantee – in the event that EQC's reserves and reinsurance lines are exhausted.

4.2. Research and education

Research and education informs risk management decisions taken by EQC. EQC's research programme, valued at around $16m annually, aims to grow New Zealand's knowledge and capacity to monitor and manage those hazard risks.

In the three decades prior to the Canterbury earthquakes, EQC has been at the forefront of investment in understanding geological hazards, including seismic hazard in Christchurch (Soils & Foundations, 1991; CAENZ, 1997). The application of knowledge from those studies significantly reduced the infrastructure losses in the Canterbury earthquakes for organisations which had chosen to invest in mitigation many years earlier (CAENZ, 1997; Fenwick, T. 2012).

4.3. EQC supports New Zealand's national monitoring system

A belief in the importance of good data and shared information was behind EQC's decision in 2001 to enter a partnership with government research institute GNS Science to establish New Zealand's geological hazards monitoring system GeoNet, with EQC as funder and GNS as technical manager. This public-to-public partnership has delivered dividends well beyond what was first envisaged. GeoNet's skilled personnel use a network of geophysical instruments across New Zealand and software applications, to gather data and disseminate information about New Zealand earthquakes, volcanic activity, large landslides and the slow deformation that precedes large earthquakes. GeoNet's publicly available data enables high-quality research and provides coverage that allows research to make gains in applicability and confidence, as well as opportunities for the increased research collaboration required to effectively analyse such a large data resource. The high degree of

Figure 5: Since 2001 EQC has boosted New Zealand's ability to detect, analyse and understand geological hazards through its investment in the modern monitoring system GeoNet, and related research and education. An open data policy has attracted top academic talent together with international research partnerships and co-investment. EQC derives direct operational benefit from hazard information for both event response and risk financing.
Source: GNS Science.

system automation in near real-time permits the delivery of rapid alerts and, in certain circumstances, warnings, such as ash plume dangers to help inform aviation forecasting, and the likelihood of tsunami generated by earthquakes offshore.

GeoNet had an extensive network in Canterbury to monitor the effect to Christchurch of an earthquake on the great Alpine Fault. The beginning of the Canterbury earthquake sequence triggered further expansion of the network and the February 2011 earthquake has since become one of the better recorded earthquakes worldwide. The value of GeoNet's data was recognised, enabling decisions relating to building reconstruction, engineering standards, defining red zones and rockfall zones and reinsurance to be informed by science.

4.4. Development of the Canterbury Geotechnical Database

When the earthquakes in Canterbury happened, EQC needed to understand the behaviour of soils to guide reconstruction and to find innovative and practical ways to reduce the risk of liquefaction. To do that, EQC and many others needed much better data than was currently available. Obtaining the data and sharing it in a way that others could use became an important factor in the recovery.

From September 2010, and following each major earthquake, EQC acquired aerial photography and LiDAR (Light Detection and Ranging) elevation mapping, to guide and augment ground surveys of land movement. In late 2011, the requirement for deep geotechnical investigations was introduced for the most vulnerable land and, recognising that geotechnical resources were scarce, an area-wide collaborative investigation programme was proposed early the following year. This was accompanied by development of the Canterbury Geotechnical Database – a repository for the extensive data collected, to establish the engineering properties of the soils and understand their performance in earthquake shaking. The database, developed for the New Zealand Government by engineering firm Tonkin + Taylor, has provided a platform for geotechnical professionals to store, share and readily assess the data files of geotechnical investigations (bore holes, cone penetration tests, piezometers and groundwater monitoring, and other relevant data) during the rebuild. It now contains over 45,000 records, or in the order of $100 million worth of investigation information, and the data has on average been reused 30 times over. The Ministry of Business, Innovation and Employment (MBIE) has taken over stewardship of the database(2) in partnership with EQC and geographic constraints have now been removed with data to be entered and accessed for anywhere in New Zealand.

Once there is sufficient data this nationwide resource will enable a much greater understanding of subsurface conditions allowing building projects to be much better informed about the likely ground behaviour during earthquakes. Buildings can be more economically designed appropriate to ground conditions. The database supports the government philosophy of maximising the use of data, upload once and download multiple times. This extremely valuable dataset is commanding international interest and changing the way in which New Zealand geotechnical consultants operate, by being able to focus on competing on service and data interpretation using a much more comprehensive dataset than would otherwise be possible.

4.5. Ground improvement research

In 2013, EQC embarked on a ground improvement research programme (GIP) to inform appropriate integrated solutions for building houses on land vulnerable to liquefaction. It was coordinated by Tonkin + Taylor with assistance from leading experts from New Zealand and around the world – comprising one of the largest teams of geotechnical engineers and scientists ever to work on a single project in New Zealand. The work has led to substantial advances in the global understanding of liquefaction and its assessment and mitigation (Van Ballegooy et al., 2014; EQC and Tonkin + Taylor, 2015).

(2) https://www.building.govt.nz/about-building-performance/news-and-updates/all-news-and-updates/bc-update-187/

GIP identified, developed and trialled practical and affordable shallow ground improvement methods that could mitigate the potential for liquefaction and associated damage to houses built on land vulnerable to liquefaction. The GIP and subsequent changes to regulatory guidance have provided more affordable ground improvement options for building or rebuilding houses on residential land. (EQC and Tonkin + Taylor, 2015)

Figure 6: Ambitious science trials were undertaken in 2013 to test ways of improving the performance of soils and foundations at sites susceptible to liquefaction. The work involved research engineers from around the world and delivered new insights into the assessment and mitigation of liquefaction risk.
Source: EQC.

5. The biggest test

When the Canterbury earthquake sequence struck, EQC had a permanent staff of 22, one office in Wellington with an outsourced claims administration facility in Brisbane, Australia, and a data system back-up site in Auckland.

As a "virtual corporation" EQC outsourced all but its core function of managing risk, with the number of permanent staff considered adequate for overseeing the few thousand claims processed each year and maintaining the contingent capabilities required to handle big events.

EQC's planned operational response to a major event (Catastrophe Response Programme) had been externally reviewed in 2009. Some operational improvements were made and the overall model endorsed. For a major event, the plan set out a number of actions to allow EQC to expand rapidly. These actions were to:

- Use the pool of experienced staff who had been employed in previous events,
- Activate a number of outsourcing relationships in New Zealand and Australia,
- Draw on any excess capacity in the market, which EQC had enlarged through industry education support and an assessment capacity initiative begun in 2009, and
- Introduce training programmes to grow the total number of skilled staff available.

Initial modelling of the 4 September 2010 earthquake indicated that EQC would receive well in excess of 100,000 claims – requiring all these actions. In addition, EQC created an in-house claims handling team to supplement outsourced services. These plans enabled EQC to put 'boots on the ground' by deploying trained assessment teams from around the country and calling on outsourced Australian loss adjustment specialists (as distinct from estimators who require knowledge of local building standards and were also more readily available in the local market). The Australian specialists were contracted on the basis they were independent of a New Zealand disaster and available during the cyclical flood/bushfire seasons in their own country. Concurrently, training and outsourcing enabled a rapid expansion to 400 staff deployed in-field (mainly assessment teams) by early October.

By the end of 2010, total staff numbers were over 1,000 and the response plan had been effective at deploying field resources and increasing these in a relatively short timescale. However, the plan could not ensure the scalability of corporate support functions to sustain a recovery operation which became much more complex and lengthy as multiple events occurred. With much higher numbers of customers affected and for longer, the personalised customer experience previously delivered in small and medium scale events was no longer possible.

5.1. From insurance to reconstruction

Observing the impact of the 4 September 2010 earthquake, the Government directed EQC to take a more "hands on" role in support of reconstruction activities. Rather than settling claims in cash, which had been EQC policy, a decision was taken to appoint construction company Fletcher Construction to project manage repairs to an estimated 50,000 homes. This number grew to approximately 70,000 following the February 2011 earthquake directly beneath Christchurch (EQC, 2012).

After the first earthquake in September 2010 it became clear that, in some cases, EQC's land liability would not cover the necessary enhancement to allow ongoing residential land use, particularly near waterways where lateral spreading of the ground occurred. The Government decided to fund enhancements to land to help maintain confidence in the residential property market and, in turn, give confidence to affected communities, local government, banks and insurers to rebuild.

Claims from the Canterbury earthquake sequence are over five times larger than the "large scale event" for which the 2009 review had recommended EQC plan. That review suggested a large scale event would result in around 80,000 claims and a major Wellington earthquake assumed to result in 150,000. Based on global experience, the review had assumed EQC would only need to respond to a single event. As it turned out Canterbury endured 14 claim generating events and thousands of lesser aftershocks.

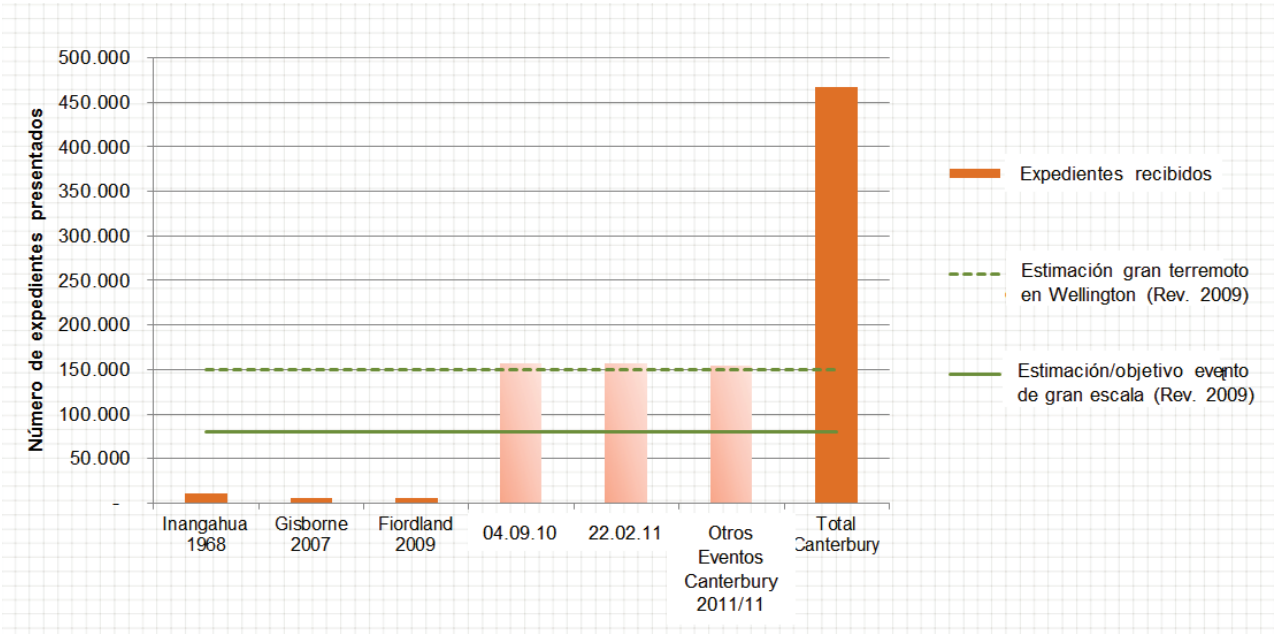

Figure 7: Prior to 2010 the largest number of claims lodged with EQC was just over 10,000, for an earthquake in a relatively remote region of the South Island in 1968. An external review of EQC's disaster response planning in 2009 anticipated approximately 150,000 claims for the maximum loss scenario (Wellington earthquake), and recommended planning for a 'large scale' event should anticipate up to 80,000 claims. The Canterbury earthquake sequence generated claims equivalent to three maximum loss events in the space of 16 months.
Source: EQC.

6. Unforeseen complexities

6.1. Difficulties arising from multiple events

The Canterbury earthquakes created operational complexities unprecedented in major insurance events worldwide. As well as the additional work created (and in some cases the previous work undone) the occurrence of multiple events meant operational challenges throughout the claims handling process, including:

- Multiple claims for a single property had to be manually associated and validated, a task made more difficult by the lack of a single, authoritative address database that could be accessed.
- A higher proportion of duplicate or invalid claims.
- A new process of apportionment to attribute damage to causative events, so that correct excess amounts and liabilities could be assigned to each event (as reinsurance contracts cover different events in different ways).
- Determining which repairs were the responsibility of private insurers was not straightforward, particularly following a High Court ruling on the reinstatement provisions of EQC's cover.
- Greater audit and review requirements.
- More complex and ultimately prolonged and frustrating, interactions for customers.

6.2. Coordination

There is a tension between fast and simple settlement by cash and the potential negative effects for cost inflation and quality or completeness of repair. The balance between maintaining flexibility and having detailed plans in place, cross-agency coordination, and the trade-offs between speed, value-for-money and customer experience has been extensively reviewed during the past six years (Deloitte Access Economics, 2015; OAG, 2012). While each review undoubtedly has at least partially met a public demand for transparency, all have suffered from a lack of cross-jurisdictional comparators that might otherwise provide international reference points against which to manage expectations. The need for industry-wide cooperation protocols within the insurance sector had been identified as a gap in disaster response planning. This included protocols around information-sharing and cost-sharing which had to be established following the earthquakes and at a time of insurance market stress and heightened uncertainty.

A challenge for future leaders of community and commercial sectors is to forecast the scale of impact at which normative behaviours and processes should be set aside in favour of unique arrangements for priority setting, information sharing, decision-making and cost allocation.

EQC's role has been only one piece of the coordination challenge facing Government and affected communities in preparing for, and responding to, natural disaster. The earthquakes have brought to the fore outstanding questions about the demands on local councils and utility infrastructure providers in a major disaster, and unresolved responsibilities around issues such as temporary housing (Middleton, 2007).

6.3. Emergency repairs

Following the February 2011 earthquake, EQC directed Fletcher Construction to focus its contractor workforce on emergency repairs and replacing broken chimneys with clean heating appliances. This averted the need for significant mass evacuation from several suburbs while delivering against insurance and reinsurance obligations as well as environmental and future health benefits through decommissioning open fires in a city historically challenged by poor winter air quality. Emergency repairs were a way for part of the customer's building claim entitlement to be used so that residents could stay in their houses. As such, they were intended to be confined to the minimum work necessary to ensure a safe, sanitary and secure home.

At Government direction, EQC also provided emergency repairs for uninsured people from 22 February until 30 April 2011. The cost of these repairs was recouped from Government. There has been no subsequent expansion of coverage for those who chose not to insure their homes.

6.4. Administrative challenges

Where a private insurer pays for repairs, rather than cash settling a claim, normal practice is that a set number of pre-approved contractors will be retained by the private insurer to carry out the repairs. This ensures quality and cost-effectiveness.

Having EQC accept invoices for emergency repairs direct from contractors resulted in significant new work for EQC. By late 2011, EQC had received over 60,000 invoices requiring processing in a system designed to settle claims, not pay accounts. In a number of cases, the rapid growth of businesses to cater for the increased demand resulted in contractors having insufficient processes of their own to meet the requirements (such as valid tax details or a fully itemised description of the work completed) for EQC to make payment.

EQC also identified cases of inflated charging, poor workmanship, works not covered by the EQC Act, and even work that was not completed or for which EQC had reimbursed a homeowner who did not pass the payment on to the contractor. All these factors contributed to well-publicised complaints about slow payments.

While the immediate impact fell on EQC, the issue was a broader one for Government with the potential for flow-on effects for other agencies (e.g. taxation) where a number of businesses had managed a large amount of work without necessarily putting in place robust administration. In future, there may be a role for business mentors, chambers of commerce in helping businesses to scale up immediately following a disaster. Trades Associations had, and will continue, to play an important role in informing cost and quality of repair standards.

6.5. Apportionment of claims

Multiple claims from almost all homeowners led to complexities in allocating the losses, and even estimating the liabilities. The loss estimation models were not calibrated for this and significant manual effort was required, falling well short of expectations of timeliness among affected parties, including homeowners, insurers and reinsurers.

EQC and private insurers were involved in every residential claim, because private insurers cover personal effects and some elements of residential property. While all parties wanted a co-ordinated industry response, multiple events within and between consecutive "insurance policy years" had never been envisaged in EQC's legislation. This led to uncertainty in the interpretation of the reinstatement provisions of EQC's cover which was resolved through a collaborative approach to the New Zealand Courts and a judicial ruling that decided EQC's cover should reinstate after each qualifying event, not annually.

6.6. Increased vulnerability to liquefaction and flooding

New Zealand is the only jurisdiction in which, through the EQC scheme, extensive land cover is available. The cover was developed for landslips, where the nature and extent of damage generally is clear. A defining attribute of the Canterbury earthquakes was the extensive land damage. There was widespread damage to houses and services on the loose saturated sandy or silty soils of the Canterbury Plains from liquefaction and lateral spreading (Leeves et al, 2012). Slope stability, rock roll and cliff collapse in the Port Hills also affected many other properties. Widespread and locally catastrophic liquefaction and thinning of the soil crust that provides the bearing capacity for housing was in some areas compounded by subsidence that locally exacerbates the flood risk. The determination of EQC's liability for restoration of the land to its pre-event state has involved complex engineering studies of the unique attributes of the damage and testing of practical repair solutions, plus legal and policy considerations that were never anticipated when the cover was devised.

Based on long-established relationships, which were strengthened during the initial response to the September 2010 earthquake, and to assist with the recovery EQC brought together a small team of experienced structural and geotechnical engineers and remediation specialists. Together they formed the Engineering Advisory Group (EAG) which advised on repair and rebuild strategies. It became apparent that the regulatory system for building work in New Zealand did not adequately address repair work for building on liquefaction-prone areas, and the stewardship of the EAG was transferred to the Government building regulator Ministry of Business, Innovation and Employment (MBIE) to guide the production of good practice guidance on the assessment, repair and rebuild of houses damaged by the earthquakes (Stannard, 2016; MBIE, 2012). The guidance has been updated progressively as new requests for assistance or developments arose during the rebuild. Updates have included building on mass movement areas, repairing multi-unit properties, the seismic design of retaining walls, incorporating ground improvement trial research results, new market developments or general clarifications. A key principle was to focus the scarce engineering resource to areas where it was most needed – the areas of highest risk.

6.7. Frequent reprioritisation

EQC plays a small role in decisions about the future of land because there are broader issues to be considered, such as damage to infrastructure, the degree of social disruption associated with different repair strategies and the overall costs and benefits of area-wide reinstatement or retirement of land affected by liquefaction, lateral spreading or slope instability. Nevertheless, EQC was directed in 2010 to project manage a programme of additional land remediation works with local councils in certain parts of Canterbury. When significant additional land damage occurred in large parts of Christchurch as a result of the 22 February 2011 earthquake, the programme was put on hold and later cancelled. However the intervening period had allowed for important work to be done which would inform the wider rebuild. Government designated a series of land zones involving a targeted retreat of housing from the worst affected areas (Residential Red Zone) and the optimisation of rebuild requirements for housing in others (Technical Category Zones 1, 2 and 3).

The land technical categories were primarily based on observed land damage. These directed where deep geotechnical investigation was needed or alternatively, where standard foundation systems could be used. Given the ongoing nature of the earthquake sequence and the nervousness of insurers to have repair work subsequently damaged, this guidance and the technical categories provided the circuit breaker necessary for approximately 80% of repairs in less vulnerable areas to progress without having to wait for specific engineering design input and deep investigation and geotechnical assessment (Leeves et al, 2012).

Figure 8: Areas worst affected by liquefaction have been 'red zoned' by Government, and retired from residential housing.
Source: Tonkin + Taylor.

These decisions during 2011 required EQC to substantially reprioritise its work. More than half of its 220 assessment teams were directed to focus on full damage assessments of all eligible properties to help inform Government and residents' decisions. In areas where the Government offered to purchase housing from private owners, team resources were reprioritised so that Government offers took into account EQC's payments to date and the estimated balance of EQC's outstanding liability.

7. What have we learned?

7.1. Memory matters

Many lessons are emerging from the Canterbury earthquakes to inform an adaptive response to natural hazard risk. The damage and loss of life in Christchurch affected a community with little prior experience of such tragedy, and these events are now etched in the collective memory of this generation. Six years of disruption and recovery of housing, roads, underground pipe networks, schools, churches, recreational amenities and the central city precincts have taken their toll. Both the social realities and the so-called "hard" data arising from these events have reshaped perceptions about hazard and vulnerability in communities throughout New Zealand, and the challenge is to translate this into practical and enduring values (Cooper et al., 2012; Stobo, 2013; Stannard, 2016).

7.2. The trade-offs within risk management need to be better understood

A decision needs to be made whether future disasters contemplated for mitigation are those which encompass a community or extend to individuals. The loss of one home is a disaster for the family affected but is not a community disaster. The loss of several thousand homes and displacement of whole neighbourhoods, as experienced in Christchurch affects an entire community.

Risk transfer was achieved in Canterbury, but the sheer scale of the damage to residential property shows that a reliance on risk-transfer alone, without comparable mitigation actions (such as avoidance and control) poses a significant challenge to community expectations of resilience as well as threatening the long-term sustainability of the insurance market.

All communities need to understand more explicitly the trade-offs available for risk treatment. In New Zealand such work reflects a much stronger imperative than in previous years with sponsorship involving Treasury, EQC, Local Government New Zealand, the Insurance Council of New Zealand, trading banks and others. Intrinsic to real progress is partnership, which demands trust and a more explicit definition of accountabilities.

7.3. Our dual insurance system needs to be more efficient

Consultation among insurers, reinsurers, banks, brokers and both central and local government agencies has indicated broad support for the retention of the EQC scheme, to sustain New Zealand's high rates of residential insurance against natural disasters and to facilitate improved understanding of hazard and risk through research and education. Many feel EQC has also played a critical role in supporting the growing understanding of natural disaster risk in New Zealand, and used this knowledge effectively in communicating and building relationships with global reinsurance markets.

Areas identified for improvement, that the legislative review is likely to address, include the sustainable pricing of EQC's cover and the clarity of its provisions as well as ways in which EQC and private insurers could more efficiently manage their shared insurance obligations for individual properties. Many stakeholders believe the way in which the dual insurance model operated in Canterbury created unnecessary cost, confusion and complexity.

7.4. High penetration rates protected New Zealand

New Zealand's high penetration rates of residential insurance cushioned the country from fiscal impact and some of the trade-offs that would otherwise have to be made across other areas of Government spending or activity, particularly given the timing of the losses closely following the global financial crisis. Through the EQC scheme and wider insurance market, New Zealand was able to meet around 80% of the costs from insurance remittances.

Other jurisdictions tend to fund after an event using different measures such as reserves, increased taxation, reduced spending elsewhere, special levies, or borrowing. When a disaster occurs, those affected face large and often personally

catastrophic losses, depending on their personal resources or savings, and facing uncertainties associated with ad hoc government assistance packages, which in themselves may be affected by prevailing domestic or international economic conditions.

In contrast, insurance provides access to funds for recovery, as well as contributing to other activities that help promote the identification and assessment of risks, and actions to decrease risk or mitigate impacts before an event.

In New Zealand, the insurance sector's financial capability was adequate, with few failures and limited demand for Government intervention despite the "uncapped" or "full replacement" liabilities which were then a feature of residential insurance cover. At the same time, New Zealand's high insurance penetration, combined with multiple earthquakes, generated high volumes of insurance claims affecting the availability of sector personnel such as loss adjustors and claims administrators.

The importance of keeping insurance affordable and available for all, by reducing risk has been argued by London-based insurer Lloyd's, citing a 22% reduction in taxpayer contribution post-disaster for every percentage increase in insurance penetration. Well-insured countries can therefore spend less on emergencies or choose to focus their spending on activities that will accelerate or enhance long-term recovery rather than provide for immediate financial assistance.

7.5. Cash settlement is easier but not always best

How insurers choose to settle their liabilities can have a direct impact on the recovery in terms of both built environment and the psycho-social effects. Generally, insurers can meet obligations by way of payment, reinstatement or relocation. While EQC is set up to settle claims in cash, having tens of thousands of Canterbury homeowners, each with an EQC cheque and trying to find a builder would have been a recipe for repair cost inflation and variable quality of repairs. The search for contractors to carry out repairs, and managing that contract once secured, would have been an intolerable burden for many distressed Canterbury residents.

There are also other direct benefits resulting from EQC's managed repair programme. 'Cost push inflation', which often features following major events and increases the cost of claims, has been contained. In addition, by ensuring houses are correctly repaired, EQC is contributing to more resilient assets and potentially lowering the costs of future claims.

7.6. A crisis requires learning and leadership

Underpinning all such risk management is knowledge and an adaptive culture. Without good data and a sound understanding of exposure and risk, judgements will be at best, haphazard. Without the capacity for adaptive learning and leadership, delivery will be compromised. It is easy to lay such challenges at the feet of others, ignoring the reality of a 'crisis' in which unifying leadership is required to transcend normative 'peacetime' roles. The challenge for private and public sector leaders alike is to ensure that commercial and regulatory arrangements, respectively, do not retard the adaptive leadership and organisational behaviours demanded of an effective response in times of crisis.

Figure 9: Damage within Christchurch's central business district as a result of the 22 February 2011 earthquake. Source: EQC.

Conclusions

If we were to generalise from our experience of the Canterbury disaster it would be to remind ourselves that insurance is a contingent form of protection that simply transfers risk to another party for a price. That price increases as the risk gets higher or is no longer available because the risk cannot be confidently assessed. Insurance is not a substitute for risk management, nor does it reduce risk. Insurance generally gives you what you had, not necessarily what you may (now) want.

There are opportunities for stronger engagement within our communities, and more consistent collaboration among private and public sector organisations and civil society to improve hazard risk management.

New Zealand's history suggests that learning from the Canterbury earthquakes is likely to deliver more consistent scientific input to public policy, revised planning rules and expectations of building performance, more transparent enterprise risk assessment for public infrastructure, refinements to EQC's remit and perhaps wider settings to ensure New Zealand will maintain a viable and an efficient insurance market. In the end it is leadership and the governance of institutions that will facilitate incremental gains and ensure that these are not eroded.

To quote an anonymous (Latin American) source of inspiration: *No es tarde, el bien como venga*. When good things arrive they are never late.

Authors

Dr Hugh Cowan

Hugh Cowan is the General Manager of Reinsurance, Research and Education and a member of the New Zealand Earthquake Commission (EQC) executive leadership team. Hugh previously led the development of New Zealand's geological hazard monitoring system "GeoNet" at the Crown Research Institute, GNS Science (1999-2005). He earlier worked as a technical consultant in the Americas and Scandinavia, contributing to international development and infrastructure projects.

Hugh is a Fellow of the NZ Society for Earthquake Engineering and a member of the New Zealand Institute of Directors.

Bryan Dunne

Bryan Dunne is the General Manager of Strategy & Transformation and a member of the New Zealand Earthquake Commission (EQC) executive leadership team. Prior to joining EQC Bryan was an advisor to New Zealand's Deputy-Prime Minister and Minister of Finance. He has worked as a senior analyst at the New Zealand Treasury, including a period on secondment from the Treasury to KPMG New Zealand.

Bryan received a 2012 Leadership Development Centre fellowship to study at the Wharton School, University of Pennsylvania and the London School of Economics.

Anna Griffiths

Anna Griffiths is the Senior Communications Adviser with the Reinsurance, Research and Education team at the New Zealand Earthquake Commission (EQC). Anna's experience spans public, private and not-for-profit sectors. A significant part of that has been within the finance sector with a particular focus on financial literacy and behaviour change, including as marketing communications manager for the award winning Sorted website (http://www.sorted.org.nz/).

Acknowledgments

We thank Priscilla Cheung, Stephanie Hamilton and Joanna Martin for valuable assistance with the preparation of figures and references, and Ben Naylor for his reporting on EQC's response during 2011 from which some of our analysis is drawn. Many people have shared the experiences described and contributed to our understanding. Any errors or omissions are ours alone, and the opinions expressed in this article are not necessarily those of the Earthquake Commission or the New Zealand Government.

References

CAENZ (New Zealand Centre for Advanced Engineering). 1997. *Risks and Realities – A multi-disciplinary approach to the vulnerability of lifelines to natural hazards.* Report of the Christchurch Engineering Lifelines Group. University of Canterbury, Christchurch, New Zealand. ISBN: 0-908993-12-9.

CAENZ (New Zealand Centre for Advanced Engineering). 2004. *Planning for Natural Hazard Risk in the Built Environment,* University of Canterbury, Christchurch, New Zealand. 52 pp.

Cooper, M., Carter, R. y Fenwick, R., 2012. *Canterbury Earthquakes Royal Commission Final Report.* Wellington.

Cowan, H., 2016. *Panel Discussion: Redesigning earthquake risk modelling approaches and techniques,* CAT Risk Management and Modelling Australasia Conference, Sydney, Australia.

Cowan, H. y Simpson, I., 2011. *Planning for Disasters and Responding to Unforeseen Complexity: The First Large Test for the New Zealand Earthquake Commission,* Aon Benfield Conference, Australia.

Cowan, H., Middleton, D. y Hooper, R., 2009. *Connections between Research and Resilience: The Role of EQC from Community Resilience: Research, Planning and Civil Defence Emergency Management,* Vol. 22, p21, TEPHRA, Ministry of Civil Defence and Emergency Management, Wellington, New Zealand.

Cowan, H., Middleton, D. y Hooper, R., 2008. *From Science to Practice: A New Zealand Case Study of Improving Natural Hazard Resilience.* 14th World Conference on Earthquake Engineering, Beijing 2008.

Deloitte Access Economics, 2015. *Four Years On: Insurance and the Canterbury Earthquakes* – Vero Insurance.

EQC, 2012. *Annual Report 2011-2012,* Wellington, New Zealand.

EQC y Tonkin + Taylor. 2015. *Residential Ground Improvement: Findings from Trials to Manage Liquefaction Vulnerability,* Wellington, New Zealand.

Fenwick, T. 2012. *The Value of Lifeline Seismic Risk Mitigation in Christchurch,* Earthquake Commission. Wellington, New Zealand.

Insurance Council of New Zealand (ICNZ), 2014. *Protecting New Zealand from Natural Hazards,* Wellington, New Zealand.

Lee, B.Y. 2010. *Working Together, Building Capacity – A Case Study of Civil Defence Emergency Management in New Zealand. Journal of Disaster Research,* vol 5 (5), pp 565-576.

Leeves, J., Sinclair, T., Stannard, M., Brunsdon, D., Traylen, N., Beattie, G., 2012. *Building in resilience for remediated residential housing,* 15th World Conference on Earthquake Engineering, Lisbon.

Lloyds, 2012; *Lloyd's Global Underinsurance Report,* compiled by the Centre for Economics and Business Research Ltd.

Middleton D. 2007. *A Roof Over Their Heads: The Challenges of Accommodation Following Disasters,* 2007 Emergency Management Conference.

Ministry of Business Innovation & Employment (MBIE), 2012. *Rebuilding and Repairing Houses Affected by the Canterbury Earthquakes,* Wellington, New Zealand.

Munich Re, 2011. Topics Geo: Natural catastrophes 2010 – Analyses, Assessments, Positions, Munich.

Office of the Auditor-General, 2012. *Roles, Responsibilities, and Funding of Public Entities After the Canterbury Earthquakes,* Wellington, New Zealand.

Park, R. y Paulay, T. 1975. *Reinforced Concrete Structures,* John Wiley and Sons, New York, USA.

Scott, G. 1996. *Government Reforms in New Zealand,* International Monetary Fund, Washington, USA.

Skinner, R.I., Robinson, W.H. y McVerry, G.H. 1993. *An Introduction to Seismic Isolation,* John Wiley & Sons, Chichester, UK.

Soils & Foundations. 1991. *Christchurch Seismic Loss Study,* Christchurch, New Zealand.

Stannard, M., 2016. *Current Direction for Improving Structural Engineering and Resiliency in New Zealand*, 16th U.S.-Japan-New Zealand Workshop on the Improvement of Structural Engineering and Resiliency, Nara, Japan.

Stobo, C. 2013. *New Zealand Local Government Insurance Market Review,* Local Government New Zealand, Wellington, New Zealand.

SSC (State Services Commission), 1998. *New Zealand's State Sector Reform: A Decade of Change*, Wellington, New Zealand.

Van Ballegooy, S., Lacrosse, V., Malan, P., Jacka, M.E., Cubrinovski, M., Bray, J.D., EERI, M., O'Rourke, T.D., EERI, M, Crawford, S.A., y Cowan, H. 2014. *Assessment of Liquefaction-Induced Land Damage for Residential Christchurch,* Earthquake Spectra, February 2014, Vol. 30, No. 1, pp. 31-55.