Canterbury earthquake response: lessons for land administration policy

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Key words: Cadastre; Legislation; Risk management

SUMMARY

In New Zealand, a series of earthquakes and aftershocks starting in 2010 in Canterbury caused widespread damage to land and buildings, disrupted property boundaries and had a significant impact on confidence in the property market. This paper discusses the pressures the land administration system faced during the disaster response and recovery phases, some difficulties faced, and outlines the major responses by the New Zealand government. We find that these responses are proving to be broadly effective, and that aspects of the response may provide lessons for other countries faced with land administration challenges following an earthquake.

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1. INTRODUCTION

In the province of Canterbury, New Zealand, starting in September 2010, a series of over 4300 earthquakes and aftershocks of magnitude 3 or greater, including 34 of magnitude greater than 5 (Geonet, 2015), caused widespread damage to land and buildings. Property boundaries were moved by as much as several metres, soil liquefaction caused buildings and other assets to move relative to the bedrock. Fences had offsets of up to 4 metres introduced (Figure 1). Several multi-story buildings collapsed including many masonry buildings.

Figure 1 Effects of fault rupture on previously straight fence and water race (Photo: Survus Consultants)

The most damaging aftershock in February 2011 was located right under the city with extremely high accelerations (over 2 times the acceleration of gravity). As well as more than 1000 buildings in the central city that had to be demolished, the infrastructure damage amounted to 1300km of roads, 660km of sewer pipes, 136 pump stations and 50km of freshwater pipes (Scott, 2013). Extensive damage to residential properties also resulted with nearly 70,000 homes repaired, over 160,000 properties with a building claim and over 180,000 claims for home contents (EQC, 2016).

Such disasters typically overwhelm the land administration systems initially. And yet these land administration systems are needed as a key contributor to recovery and reconstruction efforts and an eventual return to normality - ideally stronger and more resilient than before the disaster. Each disaster poses different problems, and each country has different land administration systems, but some themes emerge which may be able to be applied in other earthquake-prone countries.

Following the initial earthquake, and during the sequence of aftershocks, the land administration systems in New Zealand necessarily switched mode from a relatively routine transactional focus to larger scale issues of governance, legislative and regulatory responses, recovery of survey infrastructure, spatial data infrastructure and large scale land acquisition.

Relative property values across Christchurch were permanently altered by factors such as the geotechnical classification of soils regarding their suitability for building foundations, compliance of building structures with earthquake codes and the resulting ability to obtain insurance. These became important determinants of buyer confidence (Mitchell, Myers & Grant 2015; Sullivan & Grant 2012).

These all presented problems for land administration. The following section outlines some key initiatives that supported post-disaster land administration.

2. KEY ELEMENTS OF THE RESPONSE AND RECOVERY FOR LAND ADMINISTRATION

2.1 Legislation and regulations

2.1.1 Canterbury earthquake response and recovery legislation

Two acts of parliament were brought into force following the main earthquake in September 2010 and the main aftershock in February 2011. These were the Canterbury Earthquake Response and Recovery Act 2010 (CERRA2010) passed just 10 days after the 4th September 2010 earthquake, and the Canterbury Earthquake Recovery Act 2011 (CERA2011) passed 55 days after the 22nd February 2011 aftershock that cause the majority of damage.

The CERRA2010 legislation was enacted by Parliament in haste and with very limited opportunity for public comment (Gall, 2012). It provided extremely broad powers, likened by Gall to wartime powers. It essentially set aside any legislation that was deemed to impede the initial response and subsequent recovery efforts. It was very broad-brush empowering legislation allowing Orders in Council from the Executive to modify the effect of provisions in almost all other legislation within the affected part of Canterbury.

Gall describes the legislation as “draconian and an affront to democracy”. However it was enacted by parliamentary representatives who retained the power to repeal or modify it if it should prove excessive in practice. Furthermore, in 2 subsequent general elections in 2011 and 2014, the voting public seems to have broadly chosen not to be affronted by it. It may therefore

be more correct to say it was an affront to long-accepted constitutional principles than an affront to democracy itself.

The second act, CERA2011 refined and extended these powers by setting up the Canterbury Earthquake Recovery Authority (CERA) to unify the government response to the disaster. The powers of this authority were modelled on the Queensland Reconstruction Authority following 2011 floods in Queensland, Australia (Gall, 2012).

While the CERA2011 legislation also attracted some criticism for its unprecedented powers, (Gall, 2012), in terms of land administration it provided a more focused and limited response to provisions for taking land that may be required for recovery efforts. These provisions provided for fast-tracking surveys and issue of title for land-taking actions for public purposes. However it also set out protections for affected landowners. CERA2011 was drafted quickly but without the same haste as the earlier CERRA2010 and with input from relevant statutory officers including the Surveyor-General and the Registrar-General of Lands.

Whether the unprecedented breadth of the powers was necessary can be debated. However one effect, whether intended or not, was that it became immediately very clear to public officials that these were remarkable times and that business-as-usual solutions were not what the government wanted. A positive result of this refocus on solutions rather than legislation, was that where officials had reservations about proposals, they were required to outline their arguments in terms of public policy, equity, effectiveness, and avoiding unintended negative consequences or long term harm. The more easily made argument that "the law will not allow it" was generally no longer available. This was because the law provided considerable flexibility to make any new provisions deemed necessary to get Canterbury back on its feet as soon as possible.

2.1.2 Survey regulations for cadastral survey and boundary definition

One process that took advantage of the CERRA2010 and CERA2011 legislation was the 2012 amendments to the Surveyor-General's Rules for Cadastral Survey 2010 to take into account the changed circumstances in the Canterbury region. These Rules have the power of government regulation. The rule-making (regulation-making) powers have been delegated by Parliament to the Surveyor-General and include requirements for full consultation with affected stakeholders. In normal circumstances, this consultation is appropriately careful and considered – which takes time.

As described in Grant *et al*, (2015), an Order in Council allowed the Surveyor-General to forego the usual requirements of consultation to make Rules "specifying how the spatial extent (particularly boundaries) of Canterbury earthquake land must be defined and described". In practice the Surveyor-General did discuss proposals with representatives of survey professionals bodies in the Canterbury region. The Rules (Land Information New Zealand, 2012a) and associated guidelines (Land Information New Zealand, 2012b) came into force on 1 January 2013.

These amended Rules clarified the definition of boundaries affected by fault rupture (Figure 1 above, Grant *et al*, 2015; Land Information New Zealand, 2012b) but did not address many urban boundary definition issues in Christchurch city resulting from widespread and highly localised movements caused by soil liquefaction (Robertson, Dyer & Donnelly, 2016).

2.1.3 Legislative & Regulatory response to localized boundary definition issues

Although the new Rules clarified the principles of boundary definition in the case of movement of bedrock by fault rupture and distortion, a more complex situation prevailed in Christchurch City. While also subjected to movement of the bedrock, greater movement resulted from liquefaction of soils, which caused fences, houses and survey marks to move inconsistently by amounts varying from decimetres up to metres (Robertson *et al*, 2016).

The practical application of common law to boundary definition is difficult and unclear in this situation. Given the ambiguous movement of survey evidence, accepted survey practices lead to uncertain or inconsistent results (Grant & Mitchell, 2016; O'Brien, 2015; Robertson *et al*, 2016). As the earthquake recovery moved from response to rebuild the number of surveys needed increased. Surveyors became concerned about being exposed to significant liability – such as court challenge by landowners who believe they have been disadvantaged by a surveyor's boundary determination that was made without clear legal guidance.

To provide certainty, the government Cabinet approved a suite of solutions including a legislative component. A Bill was introduced which, if passed by Parliament, will provide that boundaries moved with the Canterbury earthquake sequence (O'Brien, 2015; Robertson *et al*, 2016). The Canterbury Property Boundaries and Related Matters Bill only applies to the greater Christchurch region and to the effects of this earthquake sequence. It is not intended to apply nationally or in anticipation of future similar events.

The Bill applies to all boundaries including horizontal and vertical boundaries, and fixed and moveable boundaries. The Bill acknowledges that conflicts arise between boundaries moved by the earthquake and early surveys conducted since the earthquake – especially where those surveys were based on a principle that boundaries did not move. The Bill does not seek to resolve those conflicts. Instead it validates these interim surveys and does not preclude existing conflict resolution mechanisms including civil court proceedings.

Cabinet has noted that the government agency responsible for the cadastre – Land Information New Zealand (LINZ) - will actively identify and manage those interim surveys that have the potential to create boundary conflicts.

If the Bill is enacted, the Surveyor-General will issue new Rules for cadastral surveys. For the vast majority of land parcels in greater Christchurch the movement of land does not have a material effect in relative terms. However in the worst affected areas the shape, area, and dimensions of parcels no longer reflect the existing cadastral record. New rules will set requirements to re-survey existing boundaries affected by earthquakes rather than accept the pre-earthquake position and record. Over time the cadastre will 'self-heal'.

The Bill also intends to limit liability of surveyors and those who rely on surveys in so far as the principle (whether boundaries moved or did not move) was applied on any particular survey. The final form of the solutions has yet to be decided.

2.1.4 Lessons on legislative & regulatory changes

Following a disaster, there is a clear need for strong and immediate leadership from government. A centralized empowered authority supported by other arms of government has the potential to be the most effective way of getting things done by coordinating accountabilities and communications between agencies of central and local government.

These needs were met (albeit with some controversy) by the Canterbury Earthquake Recovery Authority (CERA) and the empowering legislation, CERRA2010 and CERA2011. The legislation and the agency were broadly effective in NZ but the legislation can be criticized for being too far reaching as a result of being drafted in haste (Gall, 2012).

The best time to draft such legislation may be in a post-disaster review where lessons can be drawn calmly and clearly – before the next disaster.

The usual common law principles of boundary definition based on survey and legal evidence are applied by surveyors to individual properties in relation to their usually unaffected neighbours. However these principles are found not to work when all ”neighbours” within 50 to 100km, and all survey marks, are affected to differing degrees. In particular, in areas of liquefaction there were very localized inconsistencies.

In this case, the common law principles, to the extent they exist and are applicable, might need to change to achieve an effective public benefit balanced against equitable private property interests. The Surveyor-General is not empowered to create law or overturn common law precedents set by the courts. However Parliament can do so. The policy and technical issues are discussed in O'Brien (2015) and Robertson *et al* (2016). The potential for disputes increases with time if sufficient clarity is not in place at the time of the disaster. A pragmatic approach may be appropriate in the immediate aftermath but with the passing of time, real and potential conflicts are a risk to necessary rebuild and investment decisions.

2.2 Protecting land records and survey infrastructure

2.2.1 Land records

An illustration of the importance of survey & title records can be drawn from an earlier earthquake in New Zealand – the 1931 Hawke's Bay earthquake. The main shock was followed by fires in the city that burned for 72 hours because fire fighters had limited water supplies. Almost all of the paper titles and survey plans in the region, held in the regional land office, were destroyed. This caused severe disruption to the land administration system for many decades and the absence of pre 1931 records can still be a problem today.

Subsequently all survey plans throughout New Zealand were microfilmed by the national survey department with copies (disaster sets) held in different cities. These were later converted to digital images along with images of all title records as part of the Landonline project (Haanen, Bevin & Sutherland, 2002; Muir, 2007; Land Information New Zealand, 2016).

The lessons and responses to 1931 on the importance of protecting land records meant that there was no loss of information resulting from the 2010 and 2011 Canterbury earthquakes. Survey & title transaction processing was able to continue after the earthquakes even though the LINZ office in Christchurch was unable to be occupied for several weeks and although original paper records had been archived in a building that was unsafe to enter for some time.

2.2.2 Survey marks

The earthquakes destroyed, damaged or moved survey marks across the entire region with movements of up to several metres. Some of the movements were relatively consistent with other marks nearby as they followed deep-seated movement of bedrock and were not adjacent to the fault trace. However the movement of many other marks, close to the fault trace or affected by liquefaction of the soil layers in which they were placed, were highly localized and inconsistent (Robertson *et al*, 2016).

The importance of the survey infrastructure to recovery and rebuild efforts was recognised soon after the first earthquake. This included the need to reinstate vertical control for repair of roads, sewers and stormwater. Additional funding from government was provided for re-establishment of geodetic and vertical control. These surveys also provided scientific information on seismic processes and allowed the extent of boundary issues to be determined. Unfortunately, successive major aftershocks resulted in further movements requiring new surveys.

A secondary risk to the infrastructure of control, cadastral reference and cadastral boundary marks was also identified. This was the extensive land clearance and rebuild plans which would result in heavy earth moving equipment deployed throughout the central city for several years. In particular this threatened all survey, boundary marks as well as evidence of occupation (walls and buildings) in the central city.

A contract was let to establish new local geodetic control marks in secure locations where they were less to be disturbed – although this could not be guaranteed. The contract also sought to survey and fix sufficient cadastral boundary marks, reference marks, walls and buildings in the central city to ensure that evidence of local deformation would be preserved for future surveyors even though the marks may later be destroyed. This work was completed by GNSS and new survey datasets were lodged into the survey record (J. Johnson, personal communication, 22 February 2016). This provided preservation of survey evidence without delaying the rebuild activities. All existing survey marks surveyed were given the status of "UNPROVEN" which means that future surveyors will need to decide what weight to apply to this evidence when locating boundaries.

2.2.3 Lessons on land records and survey infrastructure

Land administration records and those survey marks that survive the immediate impact of the earthquake or disaster may remain highly vulnerable to loss in the subsequent months. Individuals, authorities and government will naturally focus on the immediate recovery needs (saving lives) restoration of basic services (water, food, shelter, power, sewerage) and early attempts to restore a working community (communications, transport, employment, shops).

Major works undertaken in haste during this phase may result in loss of records, data and survey infrastructure. The negative effects of this are likely to persist for many decades. Remote digital storage of records can alleviate this as happened with survey and title records.

High resolution remote sensing (imagery, LIDAR, InSAR) may suffice for initial capture of moved boundaries. For map-based cadastral systems (rather than the mark based system in New Zealand) this imagery may be sufficient to update cadastral records.

2.3 Survey & infrastructure contracting

Scott (2013) describes the alliance model used in Christchurch to rebuild and repair NZ$2.2 billion of physical infrastructure (roads, drainage, sewers, etc.). Initial rebuilding after the first 2010 earthquake involved each of the major contractor participants operating independently with their own systems and processes. Following the large aftershock in February 2011, the Stronger Christchurch Infrastructure Rebuild Team (SCIRT) was formed.

The daunting task after February 2011 lent itself to an alliance model based on collaboration between private sector and government partners, with common goals and objectives, seeking innovation and flexibility and relying on both public and private sector expertise.

Prior to the formation of SCIRT around 17 different survey consultancies had each been using their own methodologies, equipment, software, data formats, etc. to support recovery. After SCIRT was created, 14 survey firms were contracted to SCIRT and aligned their systems and data to maximize collaboration and data sharing (Scott, 2013).

A key part of merging competition and collaboration to maximize effectiveness was adoption of *Key Result Areas* of: on time delivery; quality; productivity; innovation; collaboration and communication; and health and safety. This ensured that all participants could prosper through collaboration and the resulting efficiency gains. All contractors shared responsibility for the success of the recovery and reconstruction efforts. A practical approach to statutory responsibilities by Surveyor-General staff also assisted (Scott, 2013).

The definition of boundaries in relation to existing and proposed infrastructure was a key task – hampered by the widespread and inconsistent movement of survey marks in the city due to soil liquefaction. Additional movements from each major aftershock necessitated resurvey and sometimes redesign.

There was also a very quick response from the land surveying community to establish survey control, and provide and share GNSS base station data. This, and the other shared survey data collected, including evidence of boundary location, will be very important for the future strength of the land administration system once the infrastructure rebuild work is completed.

2.3.1 Lessons on survey contracting

In normal times, procurement of survey contracting, which is both dependent on and contributes to the land administration system, tends towards flexibility and variety in a competitive market of independent survey contractors. However in extreme circumstances following a disaster, the SCIRT alliance model has been shown to work well. It is arguably strengthened by a professional culture amongst surveyors who are used to serving both the client and the community while also receiving fair recompense for their time and expertise.

2.4 Property related spatial data

Mercury Project Solutions (2014) identifies issues in spatial property data in the aftermath of the Canterbury earthquakes. The causes of these data issues and proposed solutions are also identified. The main issues identified were classified as:

- lack of preparedness for data sharing and integration
- lack of a central authoritative reliable address register
- decisions about data management and technology that did not follow appropriate risk management procedures
- significant gaps in availability and capture of some location data.

The root causes were identified as: the lack of data sharing agreements; lack of data sharing channels or standardisation of formats and data models; no catalogue of data sources; and lack of training in data integration.

It was found that the market driven approach before the earthquakes had reduced agency coordination and discouraged standardisation. Unstructured addresses had been used inconsistently to link data. Disaster planning had taken place but only focused on the physical response – not the data-needs response. The scale of the earthquake events overwhelmed the initial ad hoc solutions. For example, a significant data gap existed with no centralised building tenancy data available.

The proposed solution is a centralised comprehensive *Property Data Framework Model* that brings together addresses, parcels, titles, building & rating unit data. While commercial models can be used for capture and management, there is a role for government to provide the enabling framework (Mercury Project Solutions, 2014).

2.4.1 Lessons on property data

In normal times, procurement for spatial data capture and maintenance by competitive tender provides choice, flexibility, transparency and (to some extent) innovation. However it also results in inconsistent standards, data silos, complex alignment and maintenance of datasets. Data is treated as a commercial asset rather than as a community resource.

In times of disaster, data consistency, interoperability, and availability are crucial. Ad hoc solutions to data issues lead to waste and poor decisions at a time when decisions must be made quickly. What is needed is a combination of government leadership in standards and shared availability of core spatial data infrastructure holdings – together with commercial procurement in line with those standards and services (Mercury Project Solutions, 2014).

2.5 Land acquisition in the "Red Zones" & Valuation

Based on a geotechnical assessment of land damage and soil capacity, the most affected residential areas were deemed unsuitable for continued residential use. This decision was based on the likelihood of soil liquefaction in future earthquakes and the inability to provide secure building foundations or buried services (such as water, sewerage, and power) to these properties. During the recovery and reconstruction phases the New Zealand government designated 'Red Zones' (See Figure 2) that encompassed approximately 8000 land parcels – mostly adjacent to the river where the soils liquefied.

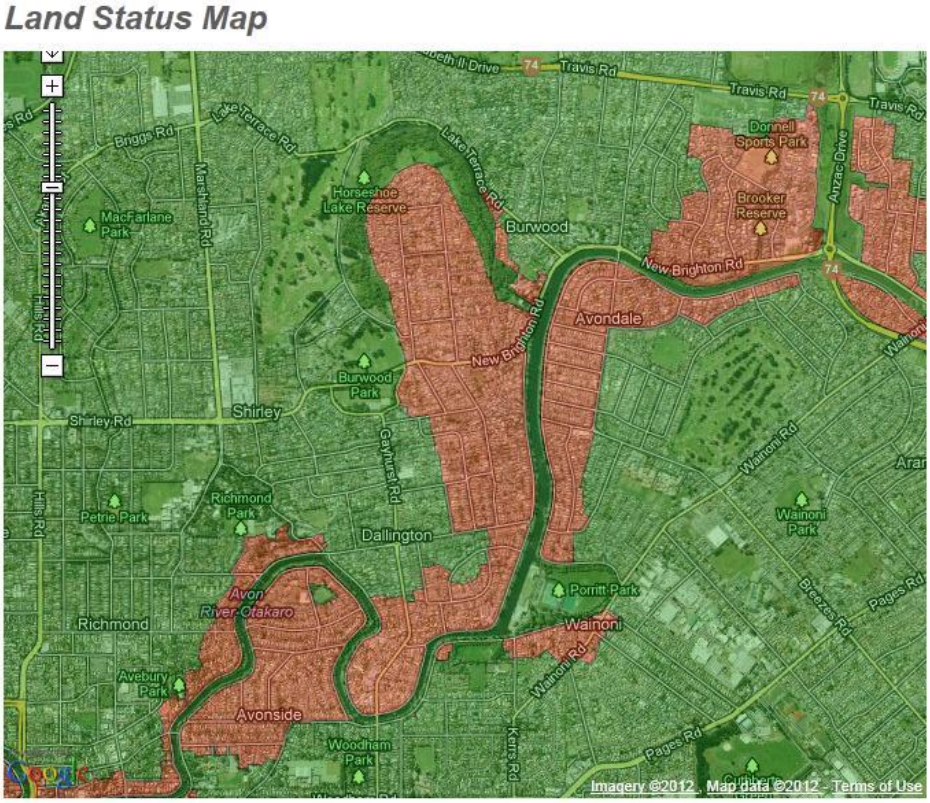

Figure 2 Some of the government-designated Red Zones in Christchurch, New Zealand (Sullivan & Grant, 2012)

The implications of this decision were that properties within the Red Zones would need to be acquired by the government, and there would be an increased demand for land and housing outside the Red Zones, with an impact on property value.

The challenge for government included the magnitude of the task of acquisition (usually conducted by individual negotiation) and the need to provide certainty to landowners as soon as possible. The government announced offers to acquire residential properties in the Red Zones that were deemed no longer able to be occupied (Canterbury Earthquake Recovery Authority, 2012). These offers commenced in 2011 and were based on the most recent mass appraisal rating valuations for Christchurch, being the values dated August 1st, 2007. These mass appraisal valuations were assessed using a market value definition for both capital value and land value across a council area and were primarily intended for council rating purposes rather than for compensation (Sullivan and Grant 2012, Mitchell *et al* 2015). Subsequent extensions of the offers to other properties have continued – also based on the 2007 valuations (Brownlee, 2015).

According to the UN FAO, one of the guiding principles is 'equivalence' in determining appropriate compensation. Equivalence means that people should receive no more or no less than their loss. However suitable undamaged houses available for resettlement became scarce

and therefore more expensive. Therefore the government offers were often not sufficient for replacement.

2.5.1 Lessons on land acquisition and valuation

Property values are collected and managed under government direction in New Zealand for the purposes of rating valuation – not for disaster response. There is central government regulatory oversight and standards for values set by the Valuer-General. Nevertheless the responsibility for conducting valuations is decentralized to local Councils. As it happened, the valuation databases proved generally adequate to this additional responsibility for disaster response and land acquisition by government. However a more centralized valuation system, aligned with other property databases, may have been better suited to the task – particularly if a larger number of Councils had been within the disaster affected area.

2.6 Government managed insurance fund

When a disaster strikes in many countries, some affected private individuals can either be uninsured or under-insured. Insurance companies may also decline to accept cover for large scale disasters. An exception was after the Canterbury earthquakes where an insurance fund applied to most residential properties. This fund is administered by the Earthquake Commission which is government-owned crown entity (EQC, 2015; Mitchell *et al*, 2015).

Despite the lack of a centralized re-settlement process, compensated landowners resettled themselves in new private sector developments on stable land on the outskirts of the city. This decentralised private resettlement approach is unusual internationally and was made possible by the Earthquake Commission fund which is generated from a levy on house insurance premiums, accumulated investments and reinsurance.

Before the 2010 earthquake, this fund had approximately NZ$8.4 billion available in funds and reinsurance (EQC, 2011). This gave affected people confidence that government would be able to manage the recovery and reconstruction, and people would receive insurance payouts. The Earthquake Commission, provides government-guaranteed insurance for up to NZ$100,000 for residential properties. Private insurance covers any loss above NZ$100,000 so the EQC payouts covered that part of the risk that private insurance companies were not prepared to cover (Earthquake Commission, 2015). This model was effective as it offered maximum private choice which suited New Zealanders in these circumstances (Grant & Mitchell 2016).

Insurance claims to EQC covered over 160,000 properties with a building claim and over 180,000 claims for home contents (EQC, 2016). From a land administration perspective, it was important that this process was underpinned by accurate and equitable property valuation, as well as accurate cadastral records. Valuation was essential in supporting insurance claims and insurance payouts (Mitchell *et al* 2015).

The earthquakes in Canterbury are estimated to have caused economic losses of approximately NZ$40 billion (NZ Government, 2013). The Insurance Council of NZ (2015) estimates NZ$15

billion of private insurance payments. The Earthquake Commission (EQC) insurance cost is estimated by Treasury to be NZ$11.7 billion giving a total insurance cover of at least NZ$26.7 billion (NZ Government, 2014). This is 67% of the total estimated damage – unusually high in international terms – reflecting the impact of the government-guaranteed EQC insurance scheme.

2.6.1 Lessons on insurance

A sound insurance scheme provides individuals with choices about how to rebuild their lives and property. However insurance on a large scale can be slow acting and may delay recovery. The New Zealand model of government-guaranteed disaster insurance worked well for Canterbury and Christchurch. However, the model of guaranteed disaster insurance supported by well developed valuation and loss-adjusting professions may not be available in emerging economies. Insurance may also introduce a financial bias for decisions on whether to repair (often cheaper and faster) or to pull down and rebuild (administratively easier).

3. NEW ZEALAND CAPACITY

The strength and adaptive capacity of the land administration system in New Zealand meant that New Zealand was in a stronger position in 2010 to respond to a major disaster than many other countries. Indicators for some aspects of this adaptive capacity are shown in Table 1.

Table 1: Indicators of capacity to respond to economic and land administration issues resulting from major earthquakes (adapted from Grant & Mitchell, 2016)

Adaptive capacity indicators	New Zealand
Estimated economic damage	US$30B
GDP[1]	US$145B (2010)
Damage as proportion of GDP	20.6% of GDP
GDP per capita[1]	US$29,390
World Bank Doing Business – Registering Property 2015[2]	1st of 189 countries
World Bank Doing Business – Construction Permits 2015[2]	2nd of 189 countries
World Bank Property rights & rule based governance index (1-low, 6=high) 2015[1]	Not available but estimated to be 6
Transparency International Corruption Perception Index 2014[3]	2nd of 175 countries

[1] World Bank Open Data (*data.worldbank.org/*)
[2] World Bank Doing Business (*www.doingbusiness.org/*)
[3] Transparency International (*www.transparency.org/cpi2014/results*)

Yet even though land administration New Zealand was strong, the system was put under considerable and unusual pressure. It is therefore reasonable to say that all countries will struggle to cope for many years following a major earthquake.

From these indicators it can also be concluded that some of the solutions found for disaster response and recovery in Canterbury may not be directly applicable in other countries with land administration systems that are not as strong. Nevertheless the underlying principles may be adaptable to other jurisdictions and communities.

4. CONCLUSION

Land administration systems (including the functions of cadastral surveying, land tenure, valuation, land-use planning, and land development) that work at the micro level in normal times (property by property, or neighbourhood by neighbourhood) may fail at the macro level when thousands, to hundreds of thousands of properties, are affected.

In general, while potential improvements to recovery efforts can be identified, the actions taken in New Zealand proved to be broadly effective. Lessons from the New Zealand experience may help other countries better prepare their land administration systems for the impact of future earthquakes, making such adaptions as are suitable to the local environment and community. Resilience focus on preparedness in earthquake-prone areas will improve the adaptive capacity of the land administration system, as well as their capacity to support the economy and the community to respond to and prepare for future disasters.

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BIOGRAPHICAL NOTES

Donald Grant was the New Zealand Surveyor General from 2004 to February 2014 – which covered the period of initial survey responses to the devastating Canterbury earthquakes in 2010 and 2011. He holds a BSc Honours in Physics from Canterbury University, a Diploma in Surveying from Otago University and a PhD in Surveying from the University of New South Wales. He registered as a surveyor in 1979 and is currently registered as a Licensed Surveyor in Victoria. Don was elected as a Fellow of the NZ Institute of Surveyors in 2007 and is New Zealand's delegate to FIG Commission 7. In 2014 he took up the position of Associate Professor in Geospatial Science at RMIT University.

David Mitchell has a PhD in land administration. Between 2011 and 2014 David was co-chair of Commission 7 Working Group 2 "Land administration, natural disasters, and climate change" (with Jaap Zevenbergen), and a member of the FIG Taskforce on Climate Change. He is the author of the FAO Land Tenure Manual "Assessing and Responding to Land Issues in Disaster Risk Management". At RMIT University he teaches cadastral surveying and land development and has a strong research focus on land tenure, climate change and natural disasters.

Mark Dyer is New Zealand's Surveyor-General. He has been in professional survey practice since 1986 and was in private practice prior to being appointed to Surveyor-General in 2014. He has been President and is a Fellow of the New Zealand Institute of Surveyors, is a member of the New Zealand Planning Institute and has recently become a Fellow of the Royal Institution of Chartered Surveyors.

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