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Use of Data for Measuring and Monitoring Recovery following the Canterbury Earthquake Sequence

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Authors

Scott Miles, University of Washington

Liesel Ritchie, Natural Hazards Center, University of Colorado, Boulder

Chris D. Poland Consulting Engineer

Yu Xiao, Texas A&M University

Nick Hedley, Simon Fraser University

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A report prepared by the Earthquake Engineering Research Institute
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Scott Miles, University of Washington
Liesel Ritchie, Natural Hazards Center, University of Colorado, Boulder
Chris D. Poland Consulting Engineer
Yu Xiao, Texas A&M University
Nick Hedley, Simon Fraser University

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Table of Contents

I. Introduction

This report presents a case study that is a part of a larger Earthquake Engineering Research Institute (EERI) effort called "Seismic Observatory for Community Resilience – A Program to Learn from Earthquakes" funded by the U.S. National Science Foundation under award number 1235573. The project builds on the multi-decade and multi-disciplinary EERI Learning From Earthquakes (LFE) program. The project is a three-year earthquake reconnaissance data assimilation effort aimed at advancing knowledge on resilience data practices and its application in the United States (EERI, 2015). The project seeks to identify and define key physical and human elements that contribute to, or inhibit, seismic resilience in U.S. communities. In the process, better understanding of the physical, social, economic, governance, and institutional factors that facilitate or slow recovery will be achieved.

A seismic resilience observatory is envisioned to house data documenting restoration, reconstruction, and recovery from past earthquakes and to provide means for disseminating, analyzing, and facilitating use of such data. The purpose of such an observatory is to facilitate comparison across disasters to learn transferable lessons for establishing frameworks to improve the resilience of human settlements around the world to future earthquakes. Beyond the potential storage and management of data, it is envisioned that a seismic resilience observatory might facilitate long-term recovery data collection (i.e., reconnaissance) and provide institutional guidance for conducting resilience reconnaissance efforts (e.g., by offering standardized methods for systematic long-term recovery data collection).

The case study described in this report is the first field study of the seismic resilience observatory project. It focuses on the reconstruction and recovery processes after the 2010-2011 Canterbury earthquake sequence. This case study was chosen for several reasons. First, the Canterbury earthquake sequence is one of the most data-rich disasters in history. Second, it occurred in an urban area similar to many in the United States. Third, New Zealand does not pose a language barrier for project investigators.

In March 2014, a five-member research team visited New Zealand for two weeks to conduct fieldwork for the case study. The combined expertise of the team included sociology, geography, urban planning, information systems, and civil engineering. The goal of the fieldwork was to observe and understand how stakeholders in New Zealand are measuring, monitoring, and acting upon potential indicators of recovery after the Canterbury earthquakes. The research team interviewed a wide range of managers, decision-makers, and researchers involved with or studying recovery from the 2010-2011 earthquake sequence.

Study participants included high-level users of data (e.g., decision-makers or those who requested the creation of the data) and the managers and creators of data. The research team interviewed representatives from a broad cross-section of organizations. During these interviews, study participants were asked to discuss their perspectives on recovery data practices in New Zealand, including the usefulness, exchangeability, and limitations of data and indicators for measuring and monitoring any aspect of recovery. The purpose of the interviews was to gather insights about organizational data practices for measuring and monitoring disaster recovery. The purpose was not to request or acquire any data or information describing the recovery progress; The goal of this case study was to identify significant themes related to recovery data practices for the Canterbury earthquake sequence that can inform alternatives for developing institutional and technological arrangements for future seismic resilience observatories.

This report is organized in eight sections. It begins with an overview of the Canterbury earthquake sequence, its impact, and aspects of the recovery process to date. The methods of the study project are then described. Subsequently, three sections detail themes related to the goals of EERI's Learning From Earthquakes program that were found from analyzing and synthesizing qualitative data collected during field interviews. The themes are 1) recovery data and indicators, 2) recommendations for practice, and 3) role of outside experts.

II. Background

Christchurch is New Zealand's second-largest city, with nearly 342,000 inhabitants, according to the 2013 Census. The greater Christchurch metropolitan area has approximately 436,000 inhabitants (Statistics New Zealand, 2016). Until the first earthquake of the sequence in 2010, this area had been considered a region of moderate seismic hazard compared to Wellington and other parts of New Zealand (Elwood et al., 2014).

An M_w7.1 earthquake struck the Canterbury region of New Zealand's South Island on September 4, 2010. The epicenter was located near the town of Darfield, approximately 35 kilometers west of Christchurch on the previously unknown Greendale fault. The earthquake caused widespread damage in the region and generated hundreds of perceptible aftershocks, with four equal to or greater than magnitude 6 (Miles et al., 2014; Elwood et al., 2014). Six months later, on February 22, 2011, another powerful earthquake struck the same region. The epicenter of the M_w6.3 earthquake was approximately 6 kilometers southeast of the center of Christchurch, on another previously unknown fault. The earthquake extended the aftershock sequence of the 2010 earthquake considerably eastward, although the fault was not believed to be a projection of the Greendale fault (EERI, 2011). The 2011 earthquake generated more than 7,300 felt aftershocks in the first year. The vertical peak ground acceleration (PGA) in central Christchurch exceeded 1.8g. In some areas, PGA reached 2.2g, the highest ever recorded in New Zealand and one of the highest ever recorded worldwide (Miles et al., 2014; Bradley, et al., 2014).

The February 2011 earthquake killed 185 people. Most of these 185 deaths (72%) occurred in the collapses of two multi-story downtown buildings, designed and constructed in the mid-60s and mid-80s, respectively (Miles et al., 2014; Elwood et al., 2014). New Zealand Treasury estimated the capital cost of the Canterbury earthquakes to be around $40 billion (English, 2013). The high shaking intensity, the simultaneous vertical and horizontal ground movement, and the extreme liquefaction of the February 2011 earthquake caused significant damage. Furthermore, many buildings had been partially damaged and weakened in the 2010 earthquake. Most of the buildings in the region were not designed to withstand the high PGA of the 2011 earthquake. In the central business district, a large number of buildings sustained damage beyond repair, including several landmark buildings, hotels, and the Christchurch cathedral. Damage was greatest in older, unreinforced masonry buildings that were constructed before strict earthquakes codes were introduced. Following the 2011 earthquake, access to 45% of the 4,000 downtown buildings was banned for safety reasons, and 1,000 buildings were marked for demolition (Miles et al., 2014). Roughly 7,500 houses in Christchurch required demolition (CERA, 2014), while almost 100,000 units needed repairs (Stuff.co.nz, 2011). Damage from landslides and liquefaction led to the designation of a residential red zone, which indicated where homes could not be rebuilt (Miles et al., 2014).

The February 2011 earthquake damaged and disrupted the main lifeline systems of the city, including roads, water and wastewater networks, and electricity transmission systems. Electric power was restored to 98% of occupied homes within two weeks of the earthquake (Giovinazzi et al., 2011). Roads and bridges were extensively damaged by significant liquefaction and lateral spreading caused by the earthquakes, as were water and wastewater systems. The Christchurch City Council (CCC) received 36,000 water and wastewater service requests in the five months following the earthquake. By the end of August 2011, work was completed on all public sewer pipes, but around 800 houses remained out of service due to private sewer pipe damage (Stevenson et al., 2011). The last portable toilet was removed in January 2014 (Miles et al., 2014). The water system restoration activities in Christchurch, completed within six months, included repair of 60 water supply wells, construction of 12 km of water mains, and repair or reconstruction of 150 km of water mains, as well as of 100 km of sub-mains. The resulting liquefaction in the eastern suburbs caused bridge approaches to settle, water pipes to fracture, waste water pipes and access points to surface, roads to sink, land to shift laterally, houses and buildings to tilt, and blanketed the area with silt (Giovinazzi et al., 2011; Miles et al., 2014).

The September 2010 earthquake increased local and national capacity to deal with the February event and the subsequent aftershocks. This included reforming and refining the region's governance structure. After the February 2011 earthquake, local governments initiated a recovery process, which was subsequently led by the Crown, with the creation of the Canterbury Earthquake Recovery Authority (CERA). CERA was formed within one month of the February 2011 earthquake. Similarly, SCIRT (Stronger Christchurch Infrastructure Rebuild Team) was formed to manage and implement reconstruction of the horizontal infrastructure.

III. Methodology

This section describes the methodology used to develop the Canterbury case study. The methodology consists of a data collection strategy and analysis approach. The purpose of the data collection strategy was to obtain a qualitative primary data set that described data practices across a broad range of sectors of recovery. The purpose of the analysis approach was to identify and enumerate major themes related to stakeholder use of data in Canterbury as they sought to understand the progress of their recovery. The two components of the methodology are described below.

The three elements of the data collection strategy consisted of study participant sampling, interview protocol, and data collection. The goal of participant sampling was to identify stakeholders from government agencies, academic institutions, and private sector organizations that either had a direct role in recovery management (broadly defined) or research. The goal of the interview protocol was to develop a semi-structured guide to ensure relative consistency across interviews conducted by the project team. Data collection was conducted through face-to-face meetings—typically involving more than one study participant and multiple members of the EERI research team.

Four sectors of recovery were used to facilitate sampling of a broad cross-section of recovery stakeholders: built environment, economy, human health, and social capital. (Originally, the natural resources sector was included, but no contacted stakeholders for this sector replied or agreed to be interviewed.) One hundred twenty-two individuals were identified and contacted to request an interview. Stakeholders were identified through a combination of existing relationships, identified report authors, and snowball sampling. From these contacts, 45 meetings were scheduled and conducted. With respect to recovery sectors, 13 meetings dealt with the built environment, 11 dealt with social capital, eight dealt with economic recovery, and eight dealt with human wellbeing. The remainder of the meetings (five) were with stakeholders who managed or researched multiple sectors. Meetings were conducted with one or more participants from 26 different public and private organizations. In multiple cases, meetings were held with participants from multiple departments or agencies within an organization. Table 1 lists the organizational affiliations of all study participants.

Table 1. Participant organizations of case study

Building Officials Institute of New Zealand	Massey University
Canterbury Development Corporation	Ministry of Business, Innovation, and Employment
Canterbury District Health Board	Ministry of Education
Canterbury Earthquake Recovery Authority	New Zealand Historical Places Trust
Canterbury Employers Chamber of Commerce	Pegasus Health
Christchurch and Canterbury Tourism Board	Reserve Bank of New Zealand
Christchurch Community Council	ResilOrgs
CORE Education Ltd	Strong Christchurch Infrastructure Rebuild Team
GNS Science	Statistics New Zealand
Healthy Christchurch	University of Canterbury
Holmes Consulting Group	University of Otago
Human Rights Commission	Victoria University
Lincoln University	

Semi-structured interviews were conducted during each of the 45 meetings. Prior to beginning the formal interview, the research team informed participants that their names would not be associated with their responses and that they could skip any questions that they did not wish to answer. In all cases, participants were asked the following primary question: *How do you or your organization understand or monitor recovery from the Canterbury earthquake sequence?* The purpose of this focusing question was to encourage participants to think about and discuss the data and data practices used to support disaster recovery with respect to their responsibilities or research interests. Otherwise, the interviewers from the project team were guided by an 18-question protocol to facilitate consistency across meetings (Table 2). The aim of the protocol was not to pose each question, but to have a menu of questions to allow for (re)direction of the conversation toward relevant insights for the study. In most instances, participants were provided the interview protocol prior to meeting.

Qualitative data were collected during each meeting. The large majority of meetings involved multiple participants from a particular organization. The project team members conducted interviews jointly, except in two cases. All participating team members took interview notes to afford evaluation of consistency and completeness. When possible, interviews were audio recorded to support quality control of notes; direct transcriptions were not made.

Thematic analysis was conducted on the qualitative data (interview notes) collected during interviews. Each of the five team-members generated initial themes based on their own notes, using excerpts and quotes as exemplars of their findings. One team member combined the initial themes in a final set of overarching themes. This team member then re-read all interview notes through the lens of the final themes, identifying excerpts associated with each theme to create a coded qualitative database of the case study interviews.

Table 2. Interview protocol for case study data collection

1. What data and indicators are important in your organization's monitoring, measuring, and evaluation of progress?
2. How do data and indicators vary for different types of your organization's operations (e.g. finance, logistics), sectors, and/or projects, etc.?
3. How are different data obtained, collected, or created?
4. What data are primary data created or collected by your organization?
5. What data are secondary data collected by your organization (e.g., from Statistics NZ)?
6. How is data collection funded or budgeted for?
7. Who oversees, evaluates, and approves different required data?
8. Who has access to what types of data and who monitors or controls this access?
9. How is data quality or fitness for use managed?
10. With which external organizations does your organization collaborate for data access (e.g., formal data sharing agreements)?
11. What software and systems are used for data collection, storage, management, and access?
12. What are formal/intended processes that data are used in making different types of decisions?
13. What are formal/unexpected ways that data are used in making different types of decisions?
14. What resource constraints (people, money, time) have limited data access and use? Which constraints were overcome and how?
15. What data were desired or would have been useful but not accessible or available?
16. What are plans to update, maintain, and use data in the future?
17. How and what data practices (all of the above questions) would you do differently after a future earthquake?
18. What recommendations would you offer to other countries/communities faced with similar data needs as you faced?

IV. Recovery Data and Indicators

Study participants offered a wide range of insights about how they understood the state of recovery in Canterbury. Many agencies and organizations in New Zealand collected or managed data describing a wide range of indicators related to the Canterbury earthquake sequence recovery. Some organizations, such as the Statistics New Zealand, collected many data prior to the earthquake but could use it as a baseline to monitor the status of recovery. Other organizations, such as CERA and SCIRT, were established after the earthquake and collected data specifically to monitor indicators related to reconstruction and recovery. Similarly, some researchers from various universities and institutions collected data specifically to study the effects of the earthquakes and recovery trends. Below, an overview is provided of some of the data collected or indicators monitored by various agencies and organizations.

Built Environment

The most widely collected and available data following the earthquake sequence documents and describes the built environment. The Ministry of Civil Defence and Emergency Management took aerial photographs two days after the February 2011 earthquake. The Ministry has aerial photos, spanning at least three years, that tell an overall story of damage, demolition, and the beginning of reconstruction. CERA developed data about building inspections, reconstruction, housing occupancy, and land use related to the residential red zone. Prior to transferring functions to inheriting Crown agencies, CERA also housed the Canterbury Geotechnical Database and all data from the detailed engineering evaluation of damaged buildings. The geotechnical database was often cited as an exemplar in data practices related to the earthquakes.

CCC's corporate data team manages most of Christchurch City Council's data, including that associated with roads, pipelines, property data, and building permits data (consenting data), which have been used for understanding recovery. CCC worked with SCIRT to track and communicate road closure data to the public. The city also conducted public surveys to understand satisfaction with road conditions. After the earthquake, CCC changed how they represent buildings; the centroid of a building footprint is now the primary geographic identity. They track the number of floors associated with a building, including the type of occupancy, such as whether it is commercial or residential. The detailed engineering evaluations developed after the February 2011 earthquake are also associated with each building footprint. CCC did not have an earthquake-prone building register before the earthquake. As a result, GNS built a dataset to understand what happened to each building. CCC created the "Share an Idea" initiative to get public input on the redevelopment for the central city of Christchurch. Over 100,000 ideas were gathered for use in the redevelopment planning process. The 100,000 ideas are data representing the views about redevelopment from a large cross-section of Canterburians. While not data directly about the built environment, it is a rich dataset about how people feel about their built environment.

SCIRT was set up to rebuild horizontal infrastructure in Christchurch. The organization used a data-driven decision process for identifying and prioritizing repair and replacement projects. This process began with damage assessments to understand basic needs. Project priorities were then determined using multi-criteria analysis. The primary criteria were related to service operations—the condition, serviceability, criticality, and maintenance costs of proposed repair or replacement. SCIRT then grouped individual repair or replacement projects with respect to system interdependencies (hydraulic and proximal) to create a larger single project to provide to contractors for delivery. Other criteria were then considered, including interdependence with critical facilities and potential construction impacts on businesses or the environment. Priorities were recalculated each quarter. SCIRT's indicators of design progress revolved around workflow steps and scheduling. Construction progress indicators revolved more around the cost aspect, as well as the number of projects completed. SCIRT representatives indicated that, depending on the purpose, their project data can be summarized by project, network, asset, street, catchments, or wards. For instance, design teams needed indicators at the project level, whereas CCC required data at the street level to support maintenance crews being able to get back into normal maintenance cycles. SCIRT utilized contractors to collect some project data. For example, contractors took geo-located photographs related to projects or specific assets. These photographs were given to SCIRT's GIS team to enter into a photo database and linked to spatial data layer, which are made available through their web-based map viewer.

Land Information New Zealand (LINZ) leads the "Better Property Services" effort—a standard geospatial data framework that serves a precursor to building information modeling (BIM). "Better Property Services" is intended to make it easier for the public to access central and local government property services and information, such as property ownership, permits, and consenting. At the time of the interviews, LINZ was building a spatial data infrastructure to track the Christchurch rebuild.

There was a leap forward in GIS data collection and digitization at the city level. The CCC's corporate data team increased from 16 to 24 staff members after the February 2011 earthquake. As noted above, there was no building footprint data before the earthquakes. Since the earthquakes, hundreds of variables were created for buildings, including the number of floors and commercial ratings. For example, building footprint and street addresses do not have a one-to-one relationship. There were multiple addresses for one building. CCC undertook work to create these data relationships to better facilitate demolition and reconstruction decision-making.

The first two weeks of the CCC data team's work was to create base maps for planning response. They moved on to track status updates on indicators such as damage and porta-loo delivery locations and quantities. (Interestingly, a CERA manager said that porta-loos were delivered to the wrong locations in many cases because data about which houses required porta-loos were not available at the time.) A CCC analyst commented that any analysis done was fairly basic because decision-makers did not make many requests. CCC's data team mainly serves the needs of the city council. For instance, CCC used the data about the built environment (e.g. pipeline and street damage) to determine the city's liability in terms of insurance (not for overall economic loss assessment). The most sophisticated analysis cited was estimating potential building collapse drop zones to facilitate decisions about where to put the CBD, as well as when to remove cordons and from where.

Economy

Initially, the Crown monitored economic recovery indicators. Subsequently, a three-person team at Canterbury Development Corporation (CDC) was responsible for this and reported to the Crown. One economic indicator used to monitor economic recovery progress was adjusted regional GNP, which was developed by CDC. For this economic indicator, the value of reconstruction was removed from the regional GNP to monitor relevant growth. Other key performance indicators for CDC were net agricultural exports and sector salary levels. The Earthquake Commission (EQC) provided earthquake insurance for residential property. CDC also monitored recovery by using data on insurance claims and payouts from EQC. A Victoria University economist suggested the use of the percentage of insurance claims processed over time as a good recovery indicator. The CDC manager interviewed believed that the quarterly economic data normally provided by Statistics New Zealand were useful, but for CDC's purposes they had to do interpolation and incorporate finer resolution data. A Victoria University researcher pointed out that nationally collected economic data are not useful at the regional scale. For example, income and price data cannot be effectively de-aggregated to the district or city level, similar to the United States Census Bureau's metropolitan statistical areas.

Statistics New Zealand is a primary source for socio-economic data about New Zealand. It collects information on households and businesses through various surveys and other means. A household economic survey is conducted by Statistics New Zealand three times a year, while a labor force survey and employment survey are done quarterly. Statistics New Zealand provides electronic card transactions at a monthly time interval. They conduct an annual business operations survey and track multiple indicators about the number, types, and sizes of businesses in the country. Statistics New Zealand tracks where jobs go, but not the migration of businesses. Interviewees from Statistics New Zealand discussed the housing shortage issue. These participants described concerns on the part of some decision-makers about inflation and construction of a surplus of housing that could lead to significant market devaluation. As a result, the agency monitored and modeled the housing market using data, for example, on building permits, home sales, and rentals bonds (damage deposits paid by renters that must be recorded with the Ministry of Business, Innovation, and Employment (MBIE) by landlords). According to those interviewed, demand for housing was the most difficult aspect of the housing market to track. Interviewees commented that the rental market was the biggest issue that needed to be understood with regard to housing.

A study participant from the Canterbury Employers Chamber of Commerce (CECC) observed that the Canterbury economy was doing well. CECC's use of data to assess recovery progress varied, with most assessments being made based on qualitative information, personal relationships and anecdotal information, and professional judgment. The CECC study participant reported that financial (investment) capital was an important indicator of recovery. According to his assessment, financial capital never left the region and no meaningful economic downturn was experienced. This individual cited the agricultural sector as having performed particularly well; conversely, he stated that "90% of the recovery" was yet to come. Part of this statement was likely based simply on the stage of reconstruction of the built environment at the time of the interview. The statement was also based on trends for two particularly hard hit sectors—tourism and higher education. For both sectors, there was significant reduction in demand from people outside of New Zealand, according to data from Statistics New Zealand. Interviewees from University of Canterbury, Victoria University, and ResOrgs similarly noted the relative performance of these sectors. For tourism recovery, CECC was focused on monitoring lost guest nights from Australia, China, and USA. Broader indicators that the Chamber cited as important were the progress on a development of a new convention center, a new sports facility, and planned tourist attractions in the Christchurch CBD.

In general, participants did not mention CERA or CCC in describing economic recovery monitoring. That said, CERA had a business recovery data team. The team mainly gathered data from developers to monitor commercial reconstruction and data on insurance payments for reconstruction. The CERA analyst mentioned that he estimated finer-resolution employment data to understand where jobs were moving across Canterbury. CERA also tracked other indicators, such as insurance payments.

The Reserve Bank of New Zealand collects and provides a wide range of economic data. Indicators include inflation, GDP, exchange rates, mortgage rates, home price indices, and household debt levels. The temporal and spatial scales of their data were not always compatible with disaster recovery needs. Representatives interviewed for this study observed that they might consider different data practices in the future for support of disaster recovery decision-making—perhaps even capturing data of the social-behavioral dimensions of New Zealanders.

Researchers and consultants have completed or are conducting a wide range of studies on economic aspects of recovery from the Canterbury earthquake sequence. A research team from Victoria University did a study of displaced employees working from home after the February 2011 earthquake. The study was commissioned by Inland Revenue and the Public Services Association—a union for government employees. They surveyed employees about several indicators, including their type of work arrangements before and after the February 2011 earthquake, length of time to be ready to work again, daily average number of hours worked from an alternative workplace (e.g., home), duration of having to work at an alternative location, and various measures of job demands and satisfaction. Researchers at Massey University were conducting a five-year national study of small businesses when the earthquakes occurred. In their final survey (2011), they were able to include earthquake-specific questions about impacts and recovery. The survey allowed them to assess differences between businesses in rural versus urban areas. Lastly, Opus Consulting described their study, which analyzed business movements after the February 2011 earthquake, using mail-forwarding data from New Zealand Post.

Social and Human Wellbeing

Demographics and population changes are common types of recovery indicators. Every five years, Statistics New Zealand conducts a national census to gather a large array of data, which includes quite specific questions—such as why a respondent decided to quit smoking. In Canterbury, the 2011 census was delayed until 2013 as a consequence of the earthquakes. Representatives from Statistics New Zealand indicated there was considerable uncertainty about how people answered census questions—whether they answered using their pre- or post-earthquake status. Interviewees from Statistics New Zealand and CCC observed that data was lacking on internal migration—where people relocated within New Zealand as a result of the earthquakes. Also noteworthy is that Statistics New Zealand does not collect data on ethnicity for external migration. Moreover, CCC did not track where residents went if they left the city and CERA did not keep track of where people went after being removed from the residential red zone. The CERA analyst interviewed for this study stated that he had used electricity use data from Orion to estimate housing occupancy in the red zones.

Multiple interviewees noted that data on homelessness were lacking. The practice of counting people on the street does not appear to be common in the region. A representative from the Human Rights Commission (HRC) noted that, in general, many in New Zealand do not believe there is a homeless problem and see no reason to measure it. A Statistics New Zealand participant agreed that homeless data were not generally collected prior to the earthquakes and that the government does not have an operational definition of homeless. For example, many homeless individuals sleep on the couches of friends and relatives and are therefore difficult to track. This participant reported that the agency did attempt to estimate post-earthquake changes in homelessness, which first required the development of a definition of homeless. There were some attempts to collect quantitative data on homelessness after the February 2011 earthquake. Statistics New Zealand did some in-person interviews with community-based organizations like Salvation Army to develop qualitative data. The Statistics New Zealand interviewee noted that there was not enough staff to efficiently collect these data.

A researcher from Lincoln University conducted a survey of wellbeing of the impacted Maori population. While not formally homeless, Maori who are not homeowners often have highly transient living arrangements, and so, development of population and migration data is difficult. Among the questions included on the survey were socio-cultural capital, such as how many Maori institutions a respondent engages in and how many generations of Maori they interact with. He found that those surveyed following the earthquakes were most concerned with issues related to housing, employment, emotional support, and the loss of community spaces to sit down and talk. The Lincoln University researcher stressed that it is difficult to get data about Maori and that low sample sizes are acceptable. As an aside, the researcher said that tracking the wellbeing of Maori is not that important—suggesting that it is the day-to-day concerns and conditions for Maori that are the most important to understand.

After the February 2011 earthquake, CERA started conducting a wellbeing survey every six months. The wellbeing surveys collects data from households related to indicators such as causes of stress, social impacts, and satisfaction with post-quake recovery efforts. Data from these surveys and other sources were compiled to create the Canterbury Wellbeing Index. Because the sample was drawn from the electoral rolls (voter registry) survey responses could be geocoded. CERA also conducted a one-time wellbeing survey on the youth population in 2013. Statistics New Zealand performed a quality of life survey just before the February 2011 earthquake. Some of these questions were included in CERA's post-quake surveys, and data from the pre-quake quality of life survey provide somewhat of a baseline for monitoring wellbeing recovery. A representative from Statistics New Zealand noted that lack of availability of data about the prevalence of mental illness posed a major challenge.

A Lincoln University professor was relatively unsatisfied with indicators for measuring wellbeing and had many suggestions for more effective indicators. Specifically, she thought data should be collected on availability and existence of support groups, that more data should be collected on the status of community meeting spaces and their availability, and that current research neglected the accessibility of elected officials and decision-makers—an important indicator of social capital. She further lamented that more data were not being collected about community and faith-based organizations to understand what was happening to these entities and how many residents were taking advantage of their services.

The study participant from the HRC believed an opportunity was missed by the Crown to use the human rights indicator framework PANTER developed by United Nations Food and Agriculture Organization (FAO). PANTHER refers to indicators about participation, accountability, non-discrimination, transparency, human dignity, empowerment, and rule of law. The HRC developed indicators based on the FAO's PANTHER to monitor recovery. In general, the participant felt that more creative indicators should have be used by recovery organizations, mentioning an international human rights indicator of the ratio of girl's toilets to boy's toilets as an example of such innovative thinking.

Participants from Canterbury District Health Board (CDHB) and University of Otago described how the Accident Compensation Corporation (ACC) receives health insurance claims data from all health providers in New Zealand and provide these data for decision-making and research. Indicators include patient presentations, patient addresses, deaths, injuries, causes, treatment choices, and costs. Similar to the ACC, CDHB is a data-rich organization regardless of the earthquake recovery process. One study participant from University of Otago assisted in developing the RHISE (Research Health Issues of Seismic Events) system. The system helps parties to share data and information and provides direct access ACC injury records from the 2010 and 2011 earthquakes. A health professional interviewed said that primary mental health data collected on a regular basis was not sufficient for recovery monitoring and that specific post-disaster indicators of service needs were required. A representative from a private health provider stated that they actively maintained a database of the service needs required by general practitioners and pharmacies to conduct business.

The education consultants interviewed, as well as those from the Ministry of Education, said that the movement of students and their families was difficult to track and not formally done. The education consultants dealt with this by going to retail centers and shopping malls to interview parents of children. This provided a qualitative understanding of recovery issues for students and families.

Cultural

Data and indicators for the cultural aspects of recovery were not a common topic raised by study participants. The most explicit example of cultural data is that associated with the University of Canterbury initiative UC CEISMIC (Canterbury Earthquake Images, Stories and Media Integrated Collection). UC CEISMIC has compiled data or data links to qualitative data related to the disaster—photos, videos, new articles, research articles, building consent requests, and building site plans, among many other data. There are over 100,000 items in CEISMIC with aspirations for over 1 million items. UC CEISMIC includes first person photo accounts of rescues and video of Canterbury residents telling their storing of loss and recovery. UC CEISMIC has multiple volumes of "The Pledge" campaign—statements that residents signed to show their commitment to Christchurch and their intent to stay. The Pledge data have all been digitized, including name, age, location, and the signatories' comments. There is documentation of many of the creative endeavors undertaken by residents after the earthquakes, such as the Gap Filler public art initiative. Data about the initiative not only include photographs, but also other items such as radio programs about Gap Filler and brochures for a Gap Filler scavenger hunt. A priority is to create spatial data by geo-tagging data, but the volume of data makes the manual task slow. Another ambitious objective of UC CEISMIC is transcribing all audio and video data entries. Researchers collaborating with UC CEISMIC have done voice and gesture analysis to see how people talk about disasters. The UC CEISMIC researchers interviewed for the study said that they "do not discriminate" against any type of data or data source. An objective of the initiative is to collect data that people do not even know the utility for yet because it might be useful in years to come.

The CERA wellbeing survey contained a few questions related to culture. For example, the questionnaire included questions about the impact of the loss of recreational, sports, and cultural facilities, as well as the loss of opportunities to engage in related pursuits. The wellbeing survey of Maori conducted by the Lincoln University professor asked about respondents' sense of Maori culture. Interestingly, he said he did not find a strong correlation between a strong sense of Maori culture and resilience. Beyond the above examples, the only other cultural indicators mentioned by study participants was progress of specific projects, such as reconstruction of the Christchurch cathedral, repair of the Canterbury Museum, and construction of a new rugby stadium.

V. Recommendations for Practice

Many participants in this study recommended data practices for future disasters, described lessons they had learned, or explained how they would have done things differently given the opportunity. Four general recommendations were identified from interviews: 1) foster innovation, 2) share and link data, 3) promote data for decision-making, and 4) balance speed and deliberation.

Foster Innovation

Spatial data was said to be very useful in supporting decision-making. Participants from the CCC and CERA mentioned that the use of spatial data can lead to better recovery decisions. Due to the lack of spatial data, CCC had to deal with geocoding the building and address data after the earthquakes, which turned out to be a big problem. Because the building footprints data were not well maintained prior to the earthquake, they faced problems such as how to assign multiple street addresses to one building footprint, as well as how to locate addresses after a building was gone. There has since been a push in other districts to do better building footprint collection and, more importantly, maintenance of this data regularly. A participant from CDHB also recommended innovations associated with address data. The participant recommended to not overwrite patient addresses in any medical records system after an address change update. Having a chain of addresses can be very valuable data for doing recovery monitoring and analysis.

Many study participants mentioned digital data collection and automated data processing as means to speed up data practices. The analog approach (e.g., paper forms) to data collection used in the immediate aftermath caused subsequent delays and transcribing errors. Text recognition software could be used to automate the process of transcription. Participants at CERA and SCIRT suggested using mobile devices and crowd sourcing to assist digital data collection. Interviewees at SCIRT also suggested the need for automatic uploading and quality assurance of data. That said, a participant from the Ministry of Civil Defence and Emergency Management noted that the use of mobile devices for building inspections was not a complete success, with some users resorting to the more familiar paper-and-pencil approach. Further, the ministry representative was not enthusiastic about the crowd sourcing efforts after the earthquakes. A CERA analyst said that if effective crowd sourcing solutions can be developed, these tools should be used in future disaster recovery data collection practices. A CERA manager lamented that crowd sourcing of data was not done to a larger degree, noting that they did not think about it in the early stages of recovery. The CERA analyst proposed that it could be possible to develop a generalizable post-disaster data schema and system for collecting, managing, and serving response and recovery data. A University of Canterbury engineering researcher felt that in the future, construction contractors be better utilized for collecting data such as photographs and locational data.

There were also suggested innovations for new data measures to inform recovery decisions. Participants at CERA, Opus Consulting, and Statistics New Zealand mentioned data collection from non-traditional sources. For instance, cell phone usage and postal forwarding forms were used to track population and business relocations. Home meter readings data from Orion were used to estimate occupancy of houses in the red zone. This required deciding what a minimal meter reading is to classify a house as occupied. Statistics New Zealand was attempting to address the lack of data on internal migration using four key data sources: primary health enrollments, school enrollments, electoral enrollments, and linked employee/employer data (LEED) (e.g., welfare payments). These data have higher temporal and spatial resolution than census data. A Statistics New Zealand interviewee said that these sources have limitations because such lags in address change updates. He also noted that young males do not tend to visit doctors, so are under enrolled. Further, welfare and electoral enrollments do not have data about youth.

The digital humanities initiative UC CEISMIC is lead by faculty in the University of Canterbury College of Arts. The researchers say that UC CEISMIC is an ecosystem of organizations and their data integrated using open source software. The UC CEISMIC system stores and affords access to data held at University of Canterbury, but more importantly integrates partner organizations' databases, protocols, and APIs (application programming interface). UC CEISMIC uses and enforces standard metadata in order to maintain a record of attributes of the data, such as source and date of creation. The consortium includes the National Library, the Ministry for Culture and Heritage, CERA, Christchurch City Libraries, Te Papa, NZ On Screen, the Canterbury Museum, the Ngai Tahu Research Centre, and The Film Archive. UC CEISMIC representatives explained that their goal is to create a "bucket for everything" with an application programming interface (or API) that allows anyone to seamlessly search and access earthquake-related data from across consortium members. UC CEISMIC researchers felt that a similar tool could be created for deployment after future disasters. UC CEISMIC interviewees proposed the re-development of their system to facilitate deployment of such a tool after future disasters around the world.

Share and Link Data

Researchers and practitioners interviewed seemed to agree that some or all aspects of data sharing agreements should be worked out before the next disaster. An interviewee at MBIE said that there needed to be more forethought about mitigating privacy concerns related to proprietary or human subjects data to facilitate faster access after data is collected. A participant at University of Canterbury mentioned that prior agreements would greatly speed up the data sharing. An interviewee from University of Otago was somewhat skeptical of the utility of this, noting people often do not read their data agreements and so might not even change post-disaster practices after an earthquake, even if it was agreed to beforehand. It was noted that there is a wealth of potential knowledge about how to set up data sharing agreements. For example, UC CEISMIC set up many agreements, including with Fairfax

Media, for providing public access to newspaper issues and photographs. Managers from SCIRT and CERA suggested expanding typical mutual aid agreements to include data sharing, not just work crews. Further, the mutual aid agreement could have specification of a standard or unified data system or GIS. A CERA manager said that the prime minister should have set up an office in Christchurch to help get people to share data and give organizations confidence to share, noting that some organizations need political cover to feel comfortable sharing their data. The CERA analyst made a simple recommendation for other communities: get the baseline data you need soon after a future hazard event when people still feel like sharing.

SCIRT offered technology insights on how to share the data. A SCIRT analyst said that jurisdictions should get asset owners to inventory what assets they have and have established GIS-based platforms for managing asset data. Other SCIRT participants suggested standardizing spatial metadata and making data interoperable between owners, contractors, and designers. For example, asset owners need fully detailed and complete specifications for what data they are expected to collect and submit. Data practices should not differ significantly between organizations' departments, management, and partners. A SCIRT information specialist described the need to choose software for daily operations that can scale to meet disaster recovery needs. Learning datasets, software, and protocols is extremely time-consuming; so staff needs time to get proficient with process outside of a disaster context. The choice of software should consider the potential workflows in both contexts. The analyst suggested that organizations should look for efficiencies prior to any events and never be satisfied with current data practices or the data an organization has. They said that it is important to keep questioning processes and data to look toward future technologies.

CERA developed a publicly available web-map system that allows the public to export spatial data in GIS format and tabular data as excel files. Metadata is available for all data, as well. All data layers are also available through an API or database connection to facilitate integration with other tools or systems. SCIRT had a web-based tool for sharing data—primarily spatial data. The system was not publically accessible. SCIRT had a process to control access by external users with project user profiles that describe the person requiring access and the purpose of the request. Access was provided once the approval had been granted. There were 28 different user roles set up within the SCIRT data sharing tool that were used to control access and usage privileges. For example, construction contractors were assigned a role with access specific to construction needs.

A widely given example of public-private data sharing was the Canterbury Geotechnical Database, which is a central repository for collectively contributing and accessing soils data for a majority of the Canterbury region. The database was funded by EQC, but was served and maintained by CERA. The database was first populated about nine months after the February 2011 earthquake. Data was contributed by government agencies, university researchers, and private companies, particularly contractors for SCIRT. The database is accessible to credentialed users through a web browser. After logging in, users can search records based on location and other search criteria. Currently data is only provided in PDF format; raw data files are not available. Statistics New Zealand created the publically accessible Earthquake Information Portal that catalogues statistical data and reports related to the Canterbury earthquakes. Staff at MBIE called the database a game-changer for the reconstruction effort.

A participant from CERA described the database as an amazing example of collaboration between agencies and the private sector; a CCC participant also called it a great example of interorganizational collaboration and data sharing. The participants from MBIE and CERA believed the database should exist beyond the reconstruction process and become a national system. A GNS scientist suggested that the system would be even more valuable if the geotechnical data was linked to building data.

Study participants cited many example of sharing between government agencies. Statistics New Zealand's data was cited often as the most transparent and widely used data by government agencies and researchers. Many participants mentioned using Statistics New Zealand data, including CERA, Reserve Bank of New Zealand, CECC, Christchurch & Canterbury Tourism, Opus Consulting, and several university researchers. CERA regularly released reports presenting the results of each wellbeing survey. A participant from CERA said that policy makers could make specific requests for analysis to be done by a CERA analyst. CDHB shared their data on mental health services being provided with CERTA to assist with CERA's wellbeing index. SCIRT had relationships with many agencies and, according to SCIRT representatives, provided access to their web-based GIS data to other organizations (after an approval process and user profile creation). Lastly, a GNS scientist said that geospatial data was well by government agencies. In particular, he highlighted SCIRT's efforts.

Researchers from UC CEISMIC at University of Canterbury said they had unprecedented success in getting media companies to provide public access to data. The researchers said they established formal protocols for handling copyrights and intellectual property, citing the fact that different providers have different requirements and needs. An external committee was set up that includes upper level university administrators to review and sign off on legal issues. UC CEISMIC provides different levels of access to information, such as interview consent forms, based on a user's role.

A CDHB representative said the agency experienced significant increases in requests for data from government, media, and researchers. This required that they improve their data management and system interoperability capacity. A large number of participants mentioned the need for integrating data from multiple agencies. Recovery requires linking data to understand the big picture and comprehensively assess the consequences. Data integration requires resolving questions of custodianship and balances between centralized and decentralized storage and management. Sharing requires considerations of inter-operability. As a Statistics New Zealand analyst complained, data is rarely in the format you want.

A GNS scientist observed that data should be kept by those who create it and then data should be shared in a distributed manner—a centralized database is not workable. An MBIE manager felt that seamless system integration across organizations is unrealistic and so inter-organizational protocols for sharing are just as important as interoperability of technology. One participant at CCC said that in the New Zealand context an external agency is best suited to link data across agencies and silos. Another possibility mentioned was temporarily transferring data ownership and maintenance responsibilities from the original data owner to the rebuild agency during the rebuild period. These participants also said that agencies should work together and help each other even if it may not have an immediate benefit to the agency because collaboration may come back with benefits in some unexpected way. A participant from GNS felt there is a need for government agencies to advertise what data they have, what format it is in, and who to talk to. Any feedback from external users will help a provider's data. Both CERA and CDHB participants felt that practitioners outside New Zealand could benefit from coming to learn from agencies and their technological approaches to data sharing.

Promote Data for Decision-Making

Interviewees suggested ways to make organizations use more data for decision-making. One GNS scientist suggested a government-wide mission to integrate scientific data across agencies and promote their use within decisions. He said this would require the large task of tailoring delivery and analysis of data. A researcher at Massey University said that universities should do more relationship building to get stakeholders to use research results for decision-making. A manager at CERA echoed that social relationships with scientists are needed to make scientific data useful. He argued that without personal relationships, data would not matter in the disaster context. The Massey University professor also stressed that communities should work now to define the research questions that need answering in the post-disaster context. This will make data more relevant to recovery decision-making. Lastly, a CDC manager stressed that organizations need to communicate with each other and the public how data are used to support decision-making. He cited specifically the failure of CERA to tell the public how the "Share an Idea" campaign data were used in recovery planning after the February 2011 Canterbury earthquake.

Several participants pointed out possible reasons why wellbeing data were not used sufficiently by CERA for decision-making despite their diligent effort in collecting the data. One problem noted was the lack of engagement of the public in the design of the survey, leading to potentially useful questions not being asked. A manager at CERA said that the agency did not ask questions in a way that lead to useful answers and, thus, data. More work is needed to determine effective ways to ask people questions about their recovery. A manager from CCC agreed and said that CERA should have talked more effectively to the public. Researchers from University of Canterbury and Massey University pointed out that data practices should change so that people, including the public, take ownership of data and the decisions made from them. Among other things, this means broadly asking the public about their wants and needs. A CCC elected official echoed this statement, emphasizing understanding the wants and needs of the public. A researcher from Massey University thought that people at the front-line of recovery practice within the government should be consulted to define the research questions so that the correct questions are asked.

One CDC participant applauded the organizational model of SCIRT for being supportive of data-driven decision-making. He observed that SCIRT effectively used data to define and prioritize projects, as well as evaluate contractor performance. This participant felt that SCIRT was more effective than other organizations in their use of data for decision-making because of their innovative organizational arrangement, leadership, and relative independence from government bureaucracy. A SCIRT analyst said "data is the platform for the rebuild." Two other study participants brought up SCIRT's use of data as an exemplar for organizations involve in manager recovery of future disasters.

An interviewee from the CDC was enthusiastic about his organization's use of data to address issues of affordable housing in the months after the disaster. He explained that they observed a poor trend on the horizon—a reduction in affordable housing stocks—and, working with government stakeholders, used data to communicate the problem to the city and to the ministry. This process resulted in an agreement between the city and the ministry to subsidize developers to build affordable housing. The CDC manager suggested that, in general, Maslow's hierarchy could be used to make decisions about recovery priorities.

VI. Potential Roles for EERI and Outside Experts

One of the major themes from interviews with study participants was regarding the role of outside experts for supplementing data practices during the recovery process of the Canterbury earthquakes or future disasters. This can be conceived as part of a post-disaster long-term recovery reconnaissance effort where topical experts from outside the impacted country arrive to assist in some aspect of recovery data practices. Four significant sub-themes were identified from the interview data: augment capacities, facilitate data-driven decision-making, support research, and potential concerns related to experts "parachuting" into the recovery process.

Augment Capacities

The most common role suggested by study participants for outside experts is augmenting the capacities of government agency data practices for monitoring and managing recovery. Social science and public health researchers interviewed said that government agencies across New Zealand do not have the capacity to do data collection and analysis. Agencies tend to contract consultants because they do not have the appropriate capacity. There can be a perception that in-house research is expensive in government agencies. Unfortunately this creates a treadmill wherein the research capacity is never developed.

One participant from Christchurch City Council said that it would be useful to have one or more experts in (geographic) information systems arrive who have emotional detachment from the impacts of the disaster and the political conflicts in recovery. These outside experts could serve as good leaders and coordinators for recovery data practices because of their experience from past disasters and their objective ability to see the big picture. Those external to recovery management might have more time, energy, and ability to fundraise in order to link data across agencies and silos. These experts could also buffer those directly involved in recovery management from useless requests and figure out how to use donated equipment and volunteers. Social scientists at University of Canterbury lamented the missed opportunity for "embedding" external researchers within recovery activities, such as SCIRT work crews, to focus on data collection and usability. One public health researcher felt that top-level managers of recovery are submerged in their responsibilities. This participant also raised the need for emotional detachment. External researchers and practitioners can provide an increased ability to identify the most important questions to guide data collection, as well as suggest people best suited for this work. Information systems experts from University of Canterbury and CERA thought that external researchers could play a large role in evaluating the fitness for use and usability of data products—an issue that one participant from the Ministry of Education said became a subject of public complaint for them.

Seven of those interviewed felt that the primary capacity to augment with outside experts is the capacity to conduct data analysis, rather than data collection. The GNS scientist interviewed thought that, in general, enough data had been collected to inform recovery decision-making in Canterbury. One public health researcher went so far as to argue that government agencies were being unethical by collecting so much data and not analyzing it to support decision-making. A social scientist echoed the need to analyze the large volume of school-related data, while an economics researcher felt that analysis of business-level data would be most important in the years to come. This participant predicted that the volumes of census data would not be analyzed in depth to understand migration and changes in demographics after the Canterbury earthquakes. They pointed out that Statistics New Zealand only completed a cursory analysis on the data. The researcher lastly observed that it is unlikely that any agency or New Zealand researcher would try to link the range of research that has been done to get a comprehensive picture of recovery. A University of Canterbury researcher and a CERA analyst noted that many agencies simply do not know what data analysis is possible or feel like there is too much potential downside to spending the time and effort on analysis and innovation. Therefore, in the words of one participant, it is important that external researchers do more "public relations" to get stakeholders to conduct or commission data analysis.

A study participant from Christchurch City Council described an example of leveraging outside researchers to assist with analysis of their data. Data was posted online after the February 2011 earthquake and a request sent out to New Zealand analysts outside of Canterbury to analyze the data, particularly geographically. This volunteer crowd-sourced approach could leverage researchers from all over the world. The participant noted that this approach would require making finite tasks in order to produce a useable product. This takes time that those directly involved in recovery management and monitoring may not have, therefore requiring external assistance in coordinating the activity.

A final capacity that could be expanded is that of visualizing and communicating data. This was brought up in particular by a high-level manager at CERA, a social science researcher at Massey University, and a manager at the Ministry of Education. The participant from the Ministry of Education gave an example of a missed opportunity related to communicating the need for school closures and consolidation. Representatives from the ministry admitted their presentation of their data at public meetings was not simplified enough. An outside expert could have helped to determine the best way to communicate the data.

Facilitate Data-Driven Decision-Making

One of the primary goals of this study is to understand whether and how data has been used to inform decision-making for recovery from the Canterbury earthquakes. In general, study participants did not think that there was a widespread practice of data-driven decision-making. However, at least six of the study participants believed that data-driven decision-making could be facilitated with the help of external experts. Perhaps the strongest statement given was from a CCC participant who said external researchers would benefit Canterbury residents by making bold and potentially controversial conclusions from data analysis (e.g., "the data suggests the need to speed up recovery by a month").

An interviewee from the Human Rights Commission said that outside experts could come in early and advise on what data sets should be collected to best inform recovery decision-making. From past research, these experts could help identify what wellbeing indicators are normally collected (i.e., not associated with a disaster) that can be leveraged for the disaster recovery process. Such experts could also help decision-makers to understand the relevance and implications of indicator trends and analysis results. A GNS scientist speculated that having outside experts come in and ask questions may be good enough to get government agencies to do more with their data.

Three participants suggested that some agencies were “cherry picking” data to support their decisions or ideology. A Massey University professor suggested that external organizations can help deal with the issue of cherry picking. This is something that he said only the New Zealand media has dealt with up to this point, often asking agencies for the data that support their decision. External organizations may be able to create a more collaborative relationship with government agencies than media have, thus improving trust between stakeholders. This participant expressed worry that if New Zealand researchers play this role, they might get frozen out of the advisory role that many have. Regardless, he suggested that researchers start developing a “new ethics of data advocacy” that reveals issues such as data cherry picking.

Support Research

A handful of interviewees advocated for outside experts to facilitate comprehensive disaster recovery research through improved data practices. A GNS scientist argued that there is a need for a repository of case studies of recovery and some external organization may be able to develop, feed, and maintain such a repository. Participants at the HRC expressed concern that, without help from external experts, lessons from this disaster will be lost and therefore not inform recovery practices for future disasters. Additionally, one public health researcher at Massey University warned that the common practices of government agencies hiring consultants to conduct limited research might hinder cross case study comparison between disasters.

Non-profit research organizations, such as the Earthquake Engineering Research Institute (EERI), or university-based research consortia, could focus on ensuring the ability to make cross case study comparisons between events. The GNS scientist suggested that EERI or similarly credible organizations could develop data “templates” to standardize learning recovery lessons across disasters. While there will be significant differences across cases, there will be some generic lessons that need systematic data practices to identify. Participants from UC CEISMIC observed that their system could be modified and expanded to support this need.

Social scientists at University of Canterbury and Victoria University noted that government agencies that have a role in managing recovery, such as CERA and SCIRT, simply think about storing and preserving data, not about making it useful for researchers. These agencies typically do not have a long-term interest in recovery data, nor the capacity to maintain it and enhance usability. This is a major reason why researchers should be the facilitators and hosts of data that is intended for disaster research. A CCC analyst echoed the sentiment that government may not effectively maintain data, particularly if budgets are tight or if the data is not useful for day-to-day operations.

Concerns

There was clear support from study participants for the idea of outside experts aiding data collection, analysis, and use. There were also multiple concerns expressed. The two largest were concerns surrounding increased workloads for recovery stakeholders and the need to establish and maintain trust between recovery stakeholders and external experts.

An analyst at CERA explained that outside people parachuted in to help collect and manage building inspection data. He said that this worked well until the people left, creating a large void. At that point, he found it difficult to keep track of what buildings had been inspected. Similarly, an interviewee from CCC stated that only about 18 months after the February 2011 earthquake did her workload allow her to manage outside assistance for doing data collection and analysis. Prior to this, there were instances where data collection equipment and people were volunteered, but they were a burden rather than a boon. People showed up to her office and asked if they could help. However, she did not have time to do the necessary training to integrate these people into the department's workflow.

There is a potential for volunteers to download data, do pre-identified tasks, and provide a product back to recovery stakeholders. Unfortunately, making data accessible and listing tasks for external experts takes significant time. A GNS scientist interviewed cautioned that researchers need to know what they want and what they can offer in order to reduce the burden placed on recovery stakeholders. SCIRT was relatively open to the idea of researchers using their data. SCIRT, however, had a strict policy that they would provide data if—and only if—researchers have something to give back that was useful for SCIRT. Researchers at Massey University and University of Canterbury observed that this is a condition that may not be feasible or desirable to meet. Many researchers do not have the time or motivation to give back, particularly within a timeframe that can be useful to agencies, such as CERA and SCIRT—both time-limited organizations. One research consortia at University of Canterbury was concerned about providing access to data to external researchers if those researchers did not provide their own additional data or analysis results in return.

Three different participants spoke at length regarding the establishment of trust between recovery stakeholders and researchers, particularly international researchers. One from University of Canterbury civil engineering felt that it is important that government agencies reach out to researchers soon after a disaster, noting that this is rarely done. However, he pointed out that this is often justified because trust has not been established with many researchers, making it difficult for the agencies to assess the wisdom of the relationship. Another researcher interviewed elaborated that many in government tend not to respond well to unsolicited researcher requests, and that government agencies prefer to initiate the relationship. One participant observed that because of the low number of strong government-researcher relationships, the knowledge and innovations developed within academia were unknown or untrusted by those who could benefit from them after the Canterbury earthquakes. Unfortunately, in post-disaster situations there is much less time to establish trust, according to the engineering researcher. As a result, relationships need to be created between government, universities, and private consultants before a disaster—something that can be coordinated by organizations such as the Earthquake Engineering Research Institute. A GNS scientist noted that if trust must be built in the post-disaster context, the best way is for external organizations to send or employ the same people during each research trip to avoid the perception of what he called "disaster tourism by scientist"—sending new researchers each time.

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