

MANAGING THE SCIENCE/POLICY BOUNDARY
AFTER A DISASTER:
THE RESEARCH RESPONSE TO THE 2010-2011
CANTERBURY EARTHQUAKE SEQUENCE

by

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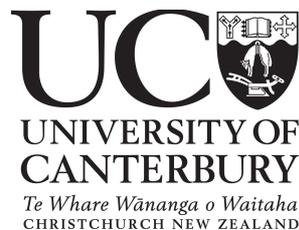
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Abstract

The Sendai Framework for Disaster Risk Reduction 2015-2030 finds that, despite progress in disaster risk reduction over the last decade “evidence indicates that exposure of persons and assets in all countries has increased faster than vulnerability has decreased, thus generating new risk and a steady rise in disaster losses” (p.4, UNISDR 2015). Fostering cooperation among relevant stakeholders and policy makers to “facilitate a science-policy interface for effective decision-making in disaster risk management” is required to achieve two priority areas for action, understanding disaster risk and enhancing disaster preparedness (p. 13, p. 23, UNISDR 2015). In other topic areas, the term science-policy interface is used interchangeably with the term boundary organisation. Both terms are usually used refer to systematic collaborative arrangements used to manage the intersection, or boundary, between science and policy domains, with the aim of facilitating the joint construction of knowledge to inform decision-making. Informed by complexity theory, and a constructivist focus on the functions and processes that minimize inevitable tensions between domains, this conceptual framework has become well established in fields where large complex issues have significant economic and political consequences, including environmental management, biodiversity, sustainable development, climate change and public health. To date, however, there has been little application of this framework in the disaster risk reduction field. In this doctoral project the boundary management framework informs an analysis of the research response to the 2010-2011 Canterbury Earthquake Sequence, focusing on the coordination role of New Zealand’s national Natural Hazards Research Platform. The project has two aims. It uses this framework to tell the nuanced story of the way this research coordination role evolved in response to both the complexity of the unfolding post-disaster environment, and to national policy and research developments. Lessons are drawn from this analysis for those planning and implementing arrangements across the science-policy boundary to manage research support for disaster risk reduction decision-making, particularly after disasters. The second aim is to use

this case study to test the utility of the boundary management framework in the disaster risk reduction context. This requires that terminology and concepts are explained and translated in terms that make this analysis as accessible as possible across the disciplines, domains and sectors involved in disaster risk reduction. Key findings are that the focus on balance, both within organisations, and between organisations and domains, and the emphasis on systemic effects, patterns and trends, offer an effective and productive alternative to the more traditional focus on individual or organisational performance. Lessons are drawn concerning the application of this framework when planning and implementing boundary organisations in the hazard and disaster risk management context.

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Co-authorship statement

Chapter 3 'Research coordination after the 2010-2011 CES and the moratorium directive' has been published as an article in the journal *Earthquake Spectra*. The candidate was first author of this article, and was solely responsible for the main concept, and for writing all drafts of the article. Supervisors Thomas Wilson and Lucy Johnston are the second and third authors, due to their extensive contributions reviewing the first and second drafts of the article and contributing to the development of the concept. Supervisors David Johnston and Richard Smith contributed to the development of the concept and reviewed the second article draft. The article has had minor revisions largely to reduce redundancy.

Chapter 5 'Boundary organisations after disasters' has been accepted for publication as an article with that title to the journal *Natural Hazards Review* (in press). The candidate was first author of this article, and was solely responsible for the original concept (and the application of the theoretical framework), and for writing all drafts of the article. Supervisors Thomas Wilson and Lucy Johnston are the second and third authors, who reviewed the first and second draft of the article as well as contributing to the development of the concept. Supervisors David Johnston and Richard Smith are the fourth and fifth authors respectively, since both contributed to the development of the concept and reviewed the second article draft. The article has had some passages removed or summarised to reduce redundancy.

1.1 Introduction

Research and technological developments over the last thirty years (Berkes 2007) have seen growing awareness of the extent to which physical, biological and social environments function as vast and intricately interlinked sets of complex systems (Duke 2006, Berkes 2007, Folke 2006, Helm 2009). While the ecological and mathematical science is complicated, the properties found to characterize complex systems can be easily conceptualized, and have been widely understood to offer new and more useful articulations of “the nature of the problems to be solved” (p. 427, Duke 2006). The idea that simple rules can drive very complex behaviours and sets of behaviours has drawn attention to the commonalities in the dynamics of complex systems as diverse as the weather, the stock market and biological ecosystems, which have all been found to manifest spontaneous emergent features, like hurricanes and stock market crashes. Generated by the interaction of behaviours within the system, these emergent features exhibit self-similarity, but cannot be predicted on the basis of their component behaviours (Finnigan 2005, Duke 2006). It follows that complex systems create irreducible uncertainty, and rather than being stable, are in a constant state of change (Berkes 2007). While this change can remain within wider regime parameters, moreover, complex systems can also be more or less resilient to sudden extreme regime shifts, or flips, as in the beginning of an ice age, the collapse of an empire, or the eutrophication of a lake (Folke 2006, Rockstrom et al. 2009, Berkes 2007).

While these findings have implications for a wide range of topic areas, they have been hailed as particularly relevant when it comes to strategies for addressing large, complex so-called wicked problems, such as biodiversity loss, climate change, the global economic crisis, and – most pertinently for this project – steadily rising disaster exposure and losses (Rockstrom et al. 2009, Duke 2006,

Berkes 2007, UNISDR 2015). This perception of relevance is usually related to the need to apply relevant scientific approaches in order to research, understand and address these problems as *complex system effects* (Duke 2006). The extent and complexity of such issues are also understood to require multi-disciplinary, integrating initiatives, which will bring researchers and end-users together to co-develop knowledge, and so improve the uptake of the understandings promised by complexity theory in action and decision-making. The establishment of coordinating governance arrangements, such as national platforms, to increase the integration of stakeholders across domains, sectors and levels, and to “foster cooperation among scientific and technological communities, other relevant stakeholders and policymakers in order to facilitate a science-policy interface for effective decision-making in disaster risk management,” for example, is a Sendai Framework for Disaster Risk Reduction guiding principle (p. 13, UNISDR 2015).

This doctoral project uses insights from complexity theory to analyze the research coordination role of a national research platform in support of response and recovery decision-making during and after the 2010-2011 Canterbury earthquake sequence in New Zealand. Three broad developments linked to this wider debate thus have an immediate bearing on the project.

Firstly, recent decades have seen the environmental management and science policy fields develop and apply constructivist research approaches informed by complex systems theory to the so-called wicked problems associated with environmental management and governance. This body of work has emerged from the study of biological ecosystems and network theory, on the one hand, and policy theory, organization theory and science and technology studies on the other (Folke 2006, Jasanoff 2011A). Diverse disciplinary origins have given rise to a range of closely related terms, including resilience, adaptive co-management or adaptive governance, boundary management or systems for the translation of knowledge into action, boundary organizations, the science-policy interface, and the umbrella term transdisciplinarity, sometimes used to refer to this family of concepts (Cash et al. 2003, Weichselgartner & Kaspersen 2012, Folke 2006, Berkes 2007, Jasanoff 2011A, Guston 2001, Van den Hoven, 2007, Sarkie et al.

2013, Regeer & Bunders 2007).¹

All these approaches conceptualize knowledge domains as complex discursive systems, and focus on the way that simple rules that drive activities in particular domains result in processes, functions and procedures that impede or enhance collaborative, integrated approaches (Cash et al. 2003, Folke 2006, Berkes 2007, Jasanoff 2011, Guston 2002, Sarkie et al. 2014). The interfaces between research, policy and decision-making domains are understood to be effects of the relevant system dynamics, constructed by the boundary work processes that occur around the interface, as individuals, groups, organizations and other relevant bodies work to maintain and develop their respective domains of expertise (Folke 2006, Crona & Parker 2012, Parker & Crona 2012, Cash et al. 2003, McNie 2007, Berkes 2009). This emphasis on system dynamics is, in effect, a widening of focus beyond the immediate specifics of science/policy interactions (such as decision-making and actions at individual or group level) to include the wider context that bears on such interactions. Moving away from the attribution of responsibility, motive or blame at individual or group levels, the focus on systemic effects instead allows the processes that occur around domain boundaries to be considered in relation to the wider scientific, policy and other domain systems that generate them. The aim is to identify factors that can be applied to more active management of boundary work processes, to reduce risks and enhance opportunities through more integrated approaches to management and governance. This framework has already been applied, to a limited extent, in the hazard and disaster management context (Berkes 2007, Folke 2006, Djalante 2012, Weichelgartner & Kasperson 2010). As Berkes notes, due to this complex systems approach to environmental management “ecosystems research has moved closer to hazards research” (p. 286, Berkes 2007). In this thesis, this movement is reciprocated. Informed by this broader, constructivist framework, the analyses that follow adapt and apply the boundary management framework in an analysis of the coordination of research response to the 2010-2011 Canterbury earthquake sequence, and so demonstrate

¹ Although it draws to at least some extent on work published under all of these terms, for

the utility of such approaches in the post-disaster context.²

Secondly, boundary management approaches can be related to debates in a wider range of complex topic areas in the science domain concerning the need for research approaches that are interdisciplinary, and that integrate the needs of research end-users (McNie 2007, Duke 2006, Folke 2006). In the hazard and disaster risk reduction field this need has been widely acknowledged for more than a decade (Tobin & Montz 1997, Miletti 1999, White et al. 2001, Alexander 2007, ICSU 2003, 2005, 2005B, 2008, 2010, UNISDR 2005, 2011, 2015, Kapucu et al. 2010, Few & Barclay 2011). In their 2011 review of the international natural hazard and disaster funding landscape, however, Few and Barclay confirmed that programs directed toward end-users were still under-explored in a research field with such important implications for society (Few & Barclay 2011). Four of their eight key recommendations addressed this finding: the promotion of integrated, inter-disciplinary approaches, the strengthening of two-way links between research providers and end-users, increased experimentation with research mechanisms (such as embedded approaches) to support more effective research/end-user partnerships, and more research into the potential offered by the national research platform approach exemplified by the New Zealand Natural Hazards Research Platform (NHRP) (Few & Barclay 2011). By adapting and applying constructivist frameworks developed in other topic areas to analyze the NHRP's coordination of research in support of Canterbury Earthquake Sequence (CES) response and recovery operations, this doctoral project is situated in the gap in this field identified by Few and Barclay (2011).

Thirdly, it is important to situate both of the preceding developments in the wider, global context. On the one hand, policy theorists have argued that the rise in importance of evidence based policy in democratically governed nations is a functional effect of the growing complexity and fragmentation of governing

² Throughout this thesis the term 'post-disaster' is used to refer to the broader time-frame in which affected social and physical environments are largely dominated by the impacts of the initial event; in the context of the Canterbury earthquakes, this period is understood to begin with the September 4th 2010 Darfield Earthquake, and to have continued to the present date (May 2015).

environments caused by globalization (Skogstad 2003, 2005, Gluckman 2013, 2014, Jasanoff 2011A). At the national level, democratic governments have responded with an increasing reliance on non-government actors for scientific, technological and other expertise and resources (Skogstad 2003, 2005, Jasanoff 2011A, 2011B, Gluckman 2013). As a result the science policy interface has become increasingly complex and blurred, or overlapping, as policy formation processes involve extended sub-governmental networks that bring relevant non-governmental actors together with policy and decision-makers (Skogstad 2003, 2005, Birkland 1998, Jasanoff 1987, 1990, 2011A). At the same time, the integration of science, technology and policy is also strongly driven by top-down global initiatives.

In the disaster risk reduction arena, reciprocal initiatives driven by the United Nations International Strategy for Disaster Reduction (UNISDR) are designed to effect this from either side of the policy/research relation. Calling for the establishment of national governance structures or multi-stakeholder platforms to integrate ongoing disaster risk reduction over time,³ the Hyogo Framework for Action 2005-2015 and the more recent Sendai Framework for Disaster Risk Reduction 2015-2030 provide guidelines that include the integration of research and science into disaster reduction policy and strategies (UNISDR 2005, 2015). UNISDR has also partnered with the International Committee for Science (ICSU) in a parallel global initiative targeting the research domain (ICSU 2008). The Integrated Research on Disaster Risk (IRDR) program was founded on concerns about the increasing distance between scientific and technological advances and the ability of society to capture and use these to reduce the impacts of disasters (ICSU 2005A). IRDR has been tasked with fostering a more integrated, multi-disciplinary international hazard and disaster research environment (ICSU 2005A, 2008). Promoting inter-disciplinary research approaches that integrate the needs of policy and decision makers (ICSU 2008), IRDR is also a response to the "great shortfall in current research on how science is used to shape social and political

³ This thesis relies on the UNISDR distinction between hazard and disaster risk management, applied to strategies, activities and measures used to prevent, mitigate and prepare for disasters, and disaster risk reduction, the umbrella term referring to the concept and practise of implementing such measures over time (UNISDR 2009).

decision-making in the context of hazards and disasters” (p. 15, ICSU 2008). Again, this doctoral project makes a start on addressing this shortfall.

Finally, this project is concerned with the New Zealand context. It has been well established that approaches to managing the science/policy interface are closely tied to cultural and normative contexts (Lentsch & Weingart 2011). The US system, for example, uses expert committees required to be representative in terms of knowledge, the UK favors the use of appropriately credentialed experts with demonstrated commitment to serving the public good, while the German model requires that collective expert bodies represent all relevant stakeholder domains (Jasanoff 2011B). In New Zealand, management of the disaster risk reduction science policy interface has been informed by recent policy shifts explicitly informed by the complex systems debate. Developed throughout the 1990s, and particularly apparent in the Civil Defence and Emergency Management (CDEM) Act 2002, these changes have been designed to move hazard and disaster risk management away from a prime focus on known hazards (the source of the problem) towards strategies designed to increase integrated, collaborative networking, and so enhance the resilience of what Helm describes as “the wider ‘Source-Community’ system” (p. 69, 2009). These have included tasking Crown Research Institutes with responsibility for science advice and support during emergency response and recovery, and the more recent formation of the national research consortium the NHRP as a first step towards building a more collaborative and networked research community. The reliance of this emerging New Zealand model of science and non-science integration on concepts taken from the complex systems debate makes the boundary management framework highly applicable when it comes to analyzing this model in action, as in this doctoral project; it is equally applicable as a tool for future planning and implementation. While this thesis is thus centrally concerned with the New Zealand systems approach to disaster risk management and security, which is described in more detail in the context section, the primary focus is on the involvement of the NHRP. The NHRP was newly formed when the earthquake sequence began in September 2010. Although not explicitly formed as a boundary organization, this consortium was awarded the functions and higher

level procedures that define boundary organizations set up to manage science/policy tensions. In addition, it was mandated to support response and recovery organizations after major natural hazard events.

1.1.1 Doctoral Project Aims:

The doctoral project has two broad aims. Using the boundary management framework as an analytic tool, it aims to tell the nuanced story of the way this national platform's research coordination role evolved in response to both the complexity of the unfolding post-disaster environment, and to national policy and research developments. The goal here is to draw lessons from this analysis of value to those planning and implementing arrangements across the science-policy boundary to manage research support for disaster risk management decision-making, particularly after disasters. The second aim is to use this case study to test the utility of the boundary management framework in the disaster risk management context. This aim requires that terminology and concepts are explained and translated into terms that are as accessible as possible across the many disciplines, domains and sectors involved in disaster risk reduction. The goal is to bring the boundary management approach further into the mainstream, in both the national New Zealand context and the international hazard and disaster risk reduction arena, where it has the potential to offer so much to other disciplines and fields, as well as to practitioners, policy and decision-makers, and other stakeholders.

1.2 Theoretical context

1.2.1 Collaboration and integration across the science/policy boundary

Recent concerns about the ability of society to use science and technology for the purposes of disaster risk reduction, and recognition of the need for more interdisciplinary, integrated approaches to hazard and disaster research are part of a growing chorus of such calls, around the world, pertaining to a range of topic areas (McNie 2007).

While commentators have noted the short fall in research directly addressing integrated approaches to research in the area of hazard and disaster risk management, such research is wide-ranging and multi-disciplinary in other, related topical areas (McNie 2007). Policy and science studies, in particular, have been investigating the integration of research and policy for many years (Clark & Majone 1985, Jasanoff 1987, 1990, McNie 2007, Lentsch & Weingart 2011). Recently, moreover, boundary management approaches to integrating research and decision-making developed in the environmental management and science policy fields have been applied in a number of new topic areas concerned with large, complex issues, including biodiversity (Koetz et al. 2011, Koetz et al. 2008, Perrings et al. 2011, Sarkki et al. 2014), sustainable development (Hotes & Opgenoorth 2014, Runhaar & van Nieuwaal 2010), climate change (Lee et al. 2014, Hoppe et al. 2013, Friman & Strandberg 2014, Iyalomhe et al. 2013) and public health (Drimie & Quinlan 2011, Casale et al. 2009, Creech 2001), as well as environmental management, where the boundary organization concept first gained traction (Cash et al. 2003, Sternlieb et al. 2013, Pesch et al. 2012, Parker & Crona 2012, Crona & Hubacek 2010, Van den Hove 2007).

Although equally applicable in the disaster risk reduction context, this framework has not as yet been widely adopted in this topic area (Folke 2006, Berkes 2009). There are some important exceptions. Most notably, Birkland's (1998, 2009) groundbreaking analyses found that some major US disaster events had a focusing effect in the policy domain. When cross-sector policy communities were established before the event, and sufficiently mobilized by this focusing effect, they were able to drive through evidence-based US disaster risk management policy, resulting in long-term cross-sector management of hazard and disaster risk. Busenberg (2000A, 2000B, 2008) follows the development of one of these arrangements over time, the collaborative management of oil spill hazard in Alaska established through legislation following the Exxon Valdez disaster. He found that in addition to relying on internal resources, this participatory mechanism depended on support from those with authority in this policy domain to translate proposed risk management measures into action (Busenberg 2000B, 2008). Although framed in terms of policy theory, rather than boundary

management, these analyses of cross-sector collaboration across the policy boundary after major disasters lay the foundation for this thesis.

More recently, Weichselgartner and Kasperson (2010) have focused closely on the science/policy interface, assessing the influence of twenty major hazard assessments in the practical disaster mitigation area on decision-making. They found that policy and decision-making was typically insufficiently informed by available, relevant research, while researchers typically failed to produce knowledge that was usable by end users. Decision-makers in disaster-related policy fields were more likely to base decision making on science, however, and much more likely to require that research processes include all stakeholders than those in non-disaster fields (Weichselgartner & Kasperson 2010).

Finally, Djalante (2012) applies this framework in a comparative assessment of the contributions of local, national, regional and global multi-stakeholder platforms to disaster risk reduction in Indonesia. As promoted by UNISDR, disaster risk reduction platforms integrate the concept and practise of disaster risk reduction across and should be strongly driven from the highest political level (p. 3, UNISDR 2007).

Djalante (2012) finds out that a sequence of high profile disaster events have stimulated the development of regional, national and local disaster risk reduction platforms in Asia, and in Indonesia specifically. At the global, regional and national level, these platforms are able to extend disaster risk reduction activities beyond the traditional responsibility of governments in Indonesia. This is due to their capacity to function as boundary organisations, able to mutually support and connect with other platforms, and recognise and strengthen the involvement of a range of stakeholders (Djalante 2012). Local Indonesian disaster risk reduction platforms, however, were largely administrative, with little obvious influence on planning and implementation; those that had made progress had done so due to strong support from the national government level, (Djalante 2012). He concludes that international and regional level tend to have more technical, financial and coordinating capacity than lower scale multi-stakeholder platforms, and that more

funding and support for local multistakeholder platforms is required from national, regional and global levels (Djalante 2012).

Consistent with the 'focusing effect' of disasters identified by Birkland (1998), Djalante's findings also bears out those of Busenberg concerning the key role of high level political support in the translation of local, collaboratively produced risk management proposals into action (Birkland 1998, 2009, Busenberg 2000B, 2008). Djalante's work is of particular value in that, like this project, its analyses are informed by the boundary management framework.

His research also provides the opportunity to briefly clarify the difference between the disaster risk reduction platforms advocated by UNISDR, that are Djalante's focus, and the national research platform, the NHRP, that is the focus of this thesis. UNISDR guidelines suggest that disaster risk reduction platforms should include "conventional economic sectors and/or ministerial or departmental divisions within the public sector, such as agriculture, finance, health, education, etc., and disaster management institutions and systems" (P3, UNISDR). This list of stakeholders is consistent with those involved in the global, regional, national and local multi-stakeholder platforms assessed by Djalante, exemplifying a strong focus on disaster risk management policy and implementation, and on the integration across economic, policy and NGO sectors (Djalante 2012). Science and technology are among the resources required for disaster risk reduction, while academia and universities are also mentioned, but to a large extent remain a given. As mentioned earlier, this focus is reversed in the global IRDR program, which is squarely focused on and situated within the science domain. The NHRP is similarly situated and focused: a research consortium, it is constituted of research organisations and concerned with the production of research.

In topic areas where boundary management approaches have been applied to other complex issues with significant social and political consequences, global platform structures more explicitly integrate science and policy domains. The Intergovernmental Panel on Climate Change (IPCC), for example, is defined on its website as both a scientific body under the auspices of the United Nations, *and* an intergovernmental body open to all UN and World Meteorological Organisation

(WMO) member countries (IPCC n.d.). Similarly, the more recently established Intergovernmental Panel on Biodiversity and Ecosystem Services is explicitly constituted as an integrated scientific and intergovernmental platform, established to “strengthen the science/policy interface for biodiversity and ecosystem services” (IPBES 2012). Subsequent discussion of the newly formed platform in *Science* has revolved around the extent to which the IPBES structure tips the balance in favor of governmental (rather than scientific) influence over IPBES decision-making (Hotes & Opengarth 2014, Perrings et al. 2011, Koetz et al 2011).

The emphasis on the involvement of science, on integrating structures and processes, and on balance across domain and sector boundaries is a defining feature of most boundary management literature. It is informed by a constructivist emphasis on the processes and functions involved in the maintenance of knowledge domain boundaries by (those engaged in) the broadly distinct domains and cultures on either side of the boundary (Clark & Majone 1985, Jasanoff 1990, 2011A, Cash et al. 2003, McNie 2007, Sarkie et al. 2014).

Indistinct, ambiguous and dynamically shifting, this boundary is understood to be constantly evolving. That dividing science and policy domains, for example, is modified and maintained by those involved as part of their professional roles, through the daily round of reinforcing and refining the evolving drivers, norms, value systems and behaviours that define the fields of expertise and policy (McNie 2007). This boundary work process is intensified, moreover, when science and policy fields are brought together, forcing scientists and decisionmakers to jointly negotiate, contest and maintain the boundary as they struggle with the fundamental tension between the primary drivers on either side: scientific credibility and political relevance (Cash & Moser 2000). At this dynamic interface, or hybrid boundary zone, the strategic demarcation of scientific and other tasks involves a degree of crossover from either side (Guston 2001, Jasanoff 2011A, 2011B, Parker & Crona 2010, Drimie & Quinlan 2011). Inevitable to some degree, this blurring of the boundary between these domains has been found to be productive when it comes to producing socially robust knowledge that is of value in both domains (Jasanoff 1990, Drimie & Quinlan 2011, Iyalomhe et al. 2013).

Equally, however, an associated potential for instability carries significant reciprocal risks to scientific credibility and political process, which are most apparent in debates and processes surrounding scientifically complex issues with significant and emotive political consequences, such as genetic modification, health and safety regulation, climate change and disaster response (Jasanoff 1990, 2011A, 2011B, Guston 2001, Hayward 2013).

Boundary management approaches are informed by these premises: since crossover between domains is inevitable, is increasing, and carries significant opportunities and risks, evidence-based management of domain boundaries has the potential to increase opportunities, while also addressing the risks. The focus of these approaches on process and function, rather than structure, has made it possible to clarify the extent to which such collaborations require a continuous process of boundary management, involving extensive deliberation, negotiation and joint learning within problem-solving networks (Carlsson & Berkes 2005). Environmental management case studies from around the world have uncovered a range of complex, dynamic processes and relationships that occur, change and develop over time, within – and bringing together – complex formal and informal social networks linking government agencies, researchers, and communities (Carlsson & Berkes 2005, Folke 2006, Berkes 2009, Crona & Hubacek 2010). Rather than being a starting point, effective collaboration has been found to be an outcome of such knowledge generating processes, and dependant on the way they continue to develop over time (Berkes 2009).

This emphasis on the collaborative process has also made it possible to identify the tightly linked relationship between three factors required by such arrangements. As early as 1985, Clark and Majone warned that while the uptake of scientific information by policy makers depended on balancing issues of (scientific) credibility and (policy) relevance, perceptions that the knowledge generating process had been legitimate, or fair and balanced in its treatment of diverging and conflicting stakeholder views were equally critical (Clark & Majone 1985). While legitimacy, or fairness thus includes the requirement that the collaborative process effectively balances credibility and relevance, subsequent findings have

confirmed that all three of these requirements are equally essential, and are so tightly linked together that the enhancement of any one component at the expense of another will put the outcome in question (Cash et al. 2003, Berkes 2009).

It should be noted that these findings apply to related collaborations across other relevant boundaries. The primary focus of this project is on the coordinating role of the NHRP after the Canterbury Earthquakes, and the potential this arrangement represents to manage boundary tensions affecting the uptake of science into policy; it is thus concerned primarily with the boundary between these larger domains. Complex systems, however, have been found to manifest self-similarity across scales (Song et al. 2005). It follows that in any large collaborative enterprise of this sort tensions created by relevant drivers are likely to play out in differing configurations around boundaries at smaller and larger scales, meaning that successful collaborations between individual approaches, between different branches of a discipline or policy field, between disciplines, or different arms of government, different nationalities, and so on will all rely on a shared perception that the processes involved have balanced relevance, credibility and legitimacy.

Three major, related streams of work, all based on this broad theoretical framework are adapted and applied in this thesis project. The earliest, and most influential of these, is represented by Cash et al. (2003), who drew on a range of existing research and environmental case studies to develop earlier findings concerning these tensions into a succinct framework for understanding the effectiveness of systems that link knowledge to decision making. They found that each driver was paired with a function, so that communication, translation and mediation functions (respectively) increased the relevance, credibility and legitimacy of collaboratively produced knowledge (Cash et al. 2003). Ongoing, inclusive communication was found to be the crucial function associated with the generation of relevant information. Perceptions of relevance diminished when the flow of communication was infrequent or flowed in only one direction (either from experts, or from policy makers), while perceptions of exclusion from the communication process led to doubts as to the legitimacy of information,

regardless of its relevance or credibility (Cash et al. 2003). By reducing misunderstandings, translation was found to improve information flow between policy and science communities divided by different languages and usages, enhancing perceptions of credibility (Cash et al. 2003). Communication and translation alone, however, cannot effectively address the fundamental tensions between relevance, credibility and legitimacy. These require active mediation to resolve conflicts, “enhancing legitimacy by increasing transparency, bringing all perspectives to the table, providing rules of conduct, and establishing criteria for decision-making” (p. 8088, Cash et al. 2003). The case studies involved clarify that the processes through which these tensions are balanced amounts to a continuous process of learning on both sides of the boundary, in order that all involved understand and commit to the criteria for credibility and relevance, producing research outputs that are of high value to all stakeholders.

These boundary management functions were found to have been most effective, moreover, in case studies where boundary-spanning institutions or procedures had been positioned across the science/policy divide to facilitate them (Guston 1999, Cash et al. 2003, McNie 2007, Berkes 2009). Whether formalized in a specialized boundary organization, or present in or across organizations with broader suites of roles and responsibilities, three institutional features characterised effective science/policy collaborations (Cash et al. 2003). Firstly, serious commitment high level commitment to managing boundaries between science and policy was necessary, including significant investment in communication, translation and mediation functions. Secondly, it was critical that key actors on both sides of the science/policy divide were made institutionally accountable for boundary management, and so forced to address the interests, concerns and perspectives of those from both sides. The third procedure involved the joint, collaborative production of boundary objects, or outputs such as reports, models, scenarios and workshops. By involving end-users early in defining data needs, these processes enhanced the relevance of the output; including a range of expertise enhanced credibility, and legitimacy was increased by the provision of more transparent access to the research development process to multiple stakeholders (Cash et al. 2003).

Subsequently dubbed CRELE (CRedibility, RElevance, LEgitimacy) (Sarkki et al. 2014), Cash et al.'s (2003) framework has been widely used in a range of topic areas to examine the balance of tensions arising out of science/policy collaborations in more detail, and in relation to time. End-users, for example, have been found to prefer more applied, consultative scientific approaches, involving a range of disciplines, whereas scientific organizations and funding agencies value basic science, conducted autonomously within a particular discipline over longer time periods (Parker & Crona, 2012, Sarkki et al. 2014, Regeer & Bunders 2009, Van den Hove 2007). Similarly, end-user preferences for clear scientific information delivered in real time have been found to be inconsistent, respectively, with the acknowledgement of complexity and uncertainty required by scientific credibility, and with time-consuming scientific verification and peer review processes (Van den Hove 2007, Sarkki et al. 2014). Parker and Crona (2012) have conceptualised such tensions and mapped them out as a spectrum, or landscape within the hybrid boundary zone between science and policy domains (Figure 1).

Note that these tensions are not understood to map literally or cleanly onto domains. Credibility, relevance and legitimacy are ideal drivers, which are important to some extent to all involved in policy and research domains, and understood in widely different ways. An actor in either domain can be positioned at a range of different points on several tension spectra at any point in time (Cash et al. 2003, Sarkki et al. 2014). The spectrum is used to schematise the trends in domain preferences that arise from principal drivers, in order to clarify aspects of the dynamic, messy processes through which boundary organizations evolve over time (Parker & Crona 2012, Sarkki et al. 2014). Although balance remains a goal, these organizations do not achieve stability as such, but rather enable a collaborative knowledge creation process that continues to unfold unpredictably across tensions within the hybrid boundary zone. Charting the development of a US boundary organization over four years of operation, for example, Parker and Crona (2012) found that an early focus on applied research addressing stakeholder needs gave way to a focus on basic science, due to pressure from both the academic community and research funding bodies; over time, this focus shifted back in the direction of addressing stakeholder needs (Parker & Crona 2012). They

represented these changes in research focus as position shifts back and forth across the tension spectrum inside this zone. This boundary organization's shifting focus was attributed to changes in the relative ability of stakeholders, over time, to affect funding and other decision-making by proving that their interests were more compelling, or salient than those of other stakeholders (Parker & Crona 2012). Saliency is the combined effect of perceptions of the stakeholder's power to affect decision-making, their legitimacy (in relation to norms and values), and the urgency of their claim (Mitchell et al. 1997, cited in Parker & Crona 2012). Thus boundary organizations necessarily remain in a dynamic, fluid state, continually adapting to the divergent, changing and sometimes fundamentally incommensurate interests of a range of stakeholders who hold unequal and changing levels of decision-making influence (Parker & Crona 2012).

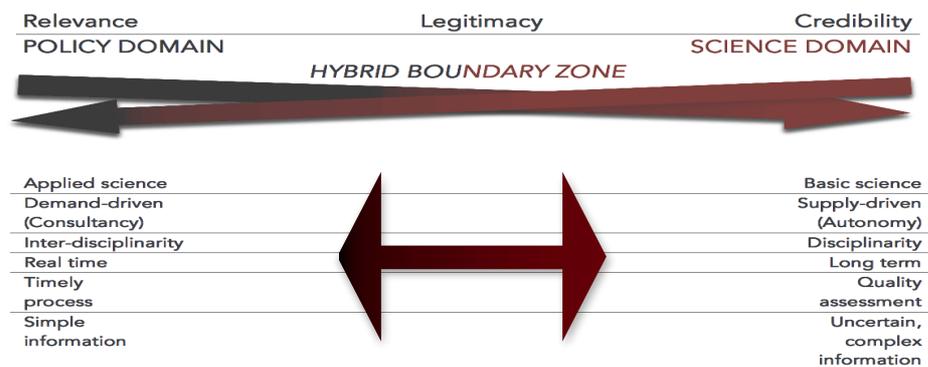


Figure 1: The tension spectrum within the hybrid boundary zone between policy and science domains (adapted from Parker & Crona 2012, Sarkki et al. 2014 & Van den Hove 2007).

Sarkki et al. (2013) also followed the development of boundary organizations over time, and also found that boundary organizations were in a constant state of adaptive management, as they struggled to keep science/policy boundary tensions in balance. Their focus, however, was on the complex trade-offs and synergies between the processes that enhance credibility, relevance and legitimacy. Since it is time-consuming to use networks to gather a range of views, there are potential synergies between the consensus-building required to achieve legitimacy, and that involved in the scientific verification and peer review processes required to ensure the credibility of scientific information (Sarkki et al. 2014, see also Parker & Crona 2012, Hackett 1997, Fordham 2007). This creates

the need for trade-offs between these consensus-building processes and the political need for the timely or rapid provision of policy-relevant knowledge. Sarkki et al. (2013) found that the latter requirement had no synergies among either credibility or legitimacy requirements. Where other trade-offs were often context specific, or resource dependent, moreover, the trade-offs required by the relevance requirement for timeliness were found to be fundamental (Sarkki et al. 2014).

The third stream of work in this area that is adapted and applied in this project is also centrally concerned with boundary organizations that are set up to manage projects across multiple domains. But rather than focusing on the tensions across *domain* boundaries, this body of work is focused on the determinative effects, over time, of decisions and judgments concerning the parameters, or boundaries, of the relevant management arrangement itself (van Meerkerk et al. 2013, Verweij et al. 2014). Their findings indicate that more flexible or wide initial parameters increase the capacity of the relevant arrangement to adapt, as time goes on, in response to issues that emerge either as a result of unforeseen consequences of the new arrangement, or related to changes in the wider environment (van Meerkerk et al. 2013, Verweij et al. 2014, van Meerkerk & Edelenbos 2014).

1.3 The post-disaster research context

Berkes (2007), Weichselgartner and Kasperson (2010) and Djalante (2012) provide support for the application of the constructivist approach developed in the environmental management field in the hazard and disaster management context. However these projects are all primarily concerned with boundary management processes that occur in the usual conditions that inform disaster mitigation research, policy and decision-making, and so with an environment that closely resembles that in which most environmental management processes occur.⁴ How

⁴ There are a number of terms used to distinguish usual decision-making environments from those affected by a disaster event. Birkland (1998) has referred to these as inter-event periods, while Olshasky et al. (2012) refer to normal times or real life. In the interests of clarity and consistency, this project uses the word usual to denote environments that are not facing the challenges associated with a recent disaster event, unless discussing the

applicable is this constructivist focus on boundary management processes, however, to the post-disaster research environment?

Olshansky et al. (2012) have established that the key feature that distinguishes post-disaster conditions from what they term normal times is the abrupt compression of development activities in time and in a limited space, as the spike in the depletion of capital services creates an immediate surge in demand for resources of all kinds, including information. Increasing globalization over recent decades has meant that normal times have involved increasing change, fragmentation and complexity across multiple domains, driving the need for integration across the boundaries that divide policy from other domains. The intensification of this need is part of the larger post-disaster surge in demand for resources, in the form of the urgent operational drive to ensure that policy and decision-making designed to respond effectively to the impact of the event is informed by evidence that is both relevant and scientifically credible. It follows that the boundary management framework is well-placed to clarify interactions between this rapidly changing environment and post-disaster management arrangements used after disasters to manage the additional complexity, across multiple domains, created by these time compression effects.

Disasters are followed by increased research opportunities and activity, as individuals and organizations are motivated to advance scientific knowledge by gathering data available only in the post-disaster context (Birkland 2009, Rodriguez et al. 2007, Liu et al. 2012, Li et al. 2011, Taskin 2010). Birkland has established that high profile disasters have had the capacity to activate science/policy collaborative initiatives that result in effective disaster risk reduction policy and decision-making (Birkland 1998). Since the compression created by disasters occurs not only in time, but also in space (Olshansky et al. 2012), this data is usually gathered in areas being actively managed by responding agencies. Overlapping with operational activities, post disaster research activities thus also necessarily involve a degree of collaboration. Both researchers and decision-

work of others.

makers must work, moreover, not only under immense time-pressure, but also with impacted populations, within the infrastructure and resource constraints caused by the disaster impact, and often under media scrutiny. It follows that, in addition to increasing research opportunities, disasters can also increase the range of risks associated with research activity in impacted areas (Birkland 2009, Rodriguez et al 2007, Citraningtyas 2010, Sumathipala 2010). Boundary management literature reveals that science/policy collaborations in any case intensify tensions around the credibility, relevance and legitimacy of knowledge. The literature concerned with appropriate research conduct after disasters suggests that these tensions are further amplified, in the post-disaster research environment, not only across the research and policy boundary, but also across a range of disciplinary, agency, institutional and national boundaries.

1.3.1 Ethical issues associated with post-disaster research

Most of the literature focused on appropriate research conduct in disaster impacted regions comes from medical and social science disciplines, and is informed by concerns about research compounding the psycho-social impacts of disasters within affected populations. Such debates are usually framed in the research ethics context, with most structured as a risk/benefit analysis of research conducted in the post-disaster environment.

The benefits generated by post-disaster research are obvious. Agencies involved in response and recovery urgently require reliable science advice, to inform situational awareness, policy and decision-making, and also public information management (Olshansky et al. 2012, Johnson & Mamula-Seadon 2014). In addition to the need for access to existing scientific knowledge, agencies also require information that can only be obtained through research carried out after the relevant disaster, to establish the extent and nature of impacts and likely secondary risks (Black 2003, Ausbrooks et al. 2009, Gill et al. 2007, Brown & Donini 2014). Conversely, there is general agreement that researchers have a duty to assist agencies and so contribute to response and recovery (Kilpatrick 2004). Post disaster data also constitutes a comparatively scarce commodity, and so

access to this directly benefit the research community, who can translate data into findings and publications, and so gain peer recognition and career advancement (Buranakul et al. 2005, Siriwardhana 2010). In the case of private providers, research data and access to research participants can also be traded as a direct source of revenue.

There is also general agreement that researchers bear a wider public good responsibility, usually framed in general, futuristic terms, as a requirement to gather and analyze post-disaster data to address the prospective needs of populations and regions impacted by future disasters (Sumathipala et al. 2010, Collogan et al. 2004, Ausbrooks et al. 2009, Knack et al. 2006). Some have argued that in view of these responsibilities, and the potential benefits of the research process and findings that may accrue to populations, it would be unethical not to conduct research after disasters (Kilpatrick 2004, Sumathipala et al. 2010).

Even the most optimistic assessments of the potential benefits of post-disaster research, however, are careful to balance these against potential risks. This risk/benefit approach is (explicitly or implicitly) informed by a recommendation in the Belmont Report (1979), which sets out the three basic principles that underpin most contemporary approaches to ethics.⁵ Developed from the Nuremberg Code, itself a response to Nuremberg trial revelations of unethical scientific practices, all three basic principles elaborate the Hippocratic maxim do no harm. The first, respect for persons, requires both that persons be considered capable of autonomous decision-making, and also that those who are not so capable, for whatever reason, be protected. The second, beneficence, stipulates that in addition to doing no harm, research has a duty to attempt, wherever possible, to actively promote wellbeing. The third, justice (or distributive justice,) requires that research benefits and burdens be distributed equably across society (1979). In addition, the Report includes guidelines for the application of these principles, requiring that research projects must establish participant capacity to make

⁵ The Belmont report is framed for medical and psychosocial research in particular. However it is now widely understood to be the basis for understandings of ethical behavior in a much wider range of contexts, as Werhane (1991) for example suggests.

autonomous decisions, and carry out risk/benefit analyses of the research in question, including the issue of distributive justice (Belmont Report 1979).

Much recent discussion of the broader ethical implications of post-disaster research appears to have responded to the above principles by focusing closely at the level of the individual participant. This includes considerations of the extent to which trauma and other disaster impacts may influence the capacity of individuals to make autonomous decisions about research participation, assessments of the potential psychological risks and benefits to individuals participating in medical and/or psycho-social research projects after disasters, and attempts to balance these against the wider 'public good' benefits of post-disaster research (Kilpatrick 2004, Levine 2004, Collogan et al. 2004, Newman & Kaloupek 2004, Rosenstein 2005, Knack et al. 2006, Dennis et al. 2006, Ausbrooks et al. 2009). Those that acknowledge the possibility that increased researcher demand for access may create an unacceptable research burden for impacted populations after disasters tend to do so only in passing (Black 2003, Brun 2009, Collogan et al. 2004, Newman & Kaloupek 2004.)

There are three notable exceptions, which contribute to the post-disaster research debate by focusing squarely on the risks posed by research practices in post-disaster environments.

The International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) report on the professional conduct of scientists during volcanic crises is the earliest significant work to extensively document the "problems of personal and institutional interaction" (p. 323, Newhall et al. 1999) that have characterized post-disaster research environments, and the only major contribution to this area from – and concerning – one of the physical sciences. For this reason, it is framed in terms of appropriate conduct, rather than ethics. Unlike medical and social scientists, physical scientists are not routinely required to interact with others as part of data collection, and so are not usually required to apply for ethics approval, or trained to consider the possible ethical implications of their research activities. In a post-disaster environment, however, visiting physical scientists

usually need to interact with local response agencies, researchers and communities to gain access to data. The report drew on extensive documented field experiences gathered by an 11 member subcommittee for crisis protocols (Newhall et al. 1999). Noting that it was usual for a primary local team of volcanologists to be made responsible for coordinating research into the relevant volcanic crisis and providing advice to local response agencies, the subcommittee reported that, during past volcanic crises, visiting scientists who had not been invited by the primary local team had often created a significant burden for local researchers, and further drained already scarce local resources (Newhall 1999). Citing instances in which such visitors had failed or refused to recognize and defer to the needs of local researchers and response agencies, and to cultural differences in local contexts, the report also noted that international scientists often struggled to communicate appropriately with local response agencies and media. Amounting to interfering with response operations, such conduct on occasion put local populations at risk (Newhall 1999).

The issues and thrust of the IAVCEI report were to be echoed, ten years later, in a special issue of the *Asian Bioethics Review* dedicated to discussions of the research environment after the 2004 tsunami in South East Asia (*Asian Bioethics Review* 2:2 2010). All contributors were in agreement with earlier publications as to the importance and value of post-disaster research. Most, however, were also members of the Working Group for Disaster Research Ethics (the Working Group), which had been convened in response to the wider impacts of the intense international research interest and activity generated by this disaster on local response agencies, communities and researchers. Accordingly, the collection of articles and case studies in this special issue documented a range of overtly unethical practices (Ahmad & Mahmud 2010, Shamim 2010, Siriwardhana, 2010, Siribaddana et al. 2010, Sumathipala et al. 2010), and the negative impact of western research approaches that conflicted with local cultural norms and values (Citraningtyas et al. 2010). Contributors documented instances in which the North-South divide significantly disempowered local agencies and researchers after the tsunami, making it difficult to conduct their own research, to support local response activities, and to effectively respond to unethical research practices by

international researchers (Siribaddana et al. 2010, Citraningtyas et al. 2010, Sumathipala et al. 2010). Moreover, they noted that while the burden of international research (including the basic need to resource the large numbers of incoming researchers and their activities) often fell on already severely impacted communities and agencies in these developing countries (Citraningtyas et al. 2010), the latter did not directly benefit from the majority of this research activity (Siribaddana et al. 2010, Citraningtyas et al. 2010, Sumathipala et al. 2010).

Both bodies, convened to address problems arising in the post-disaster research environment, effectively document instances in which research processes were perceived to completely lack either scientific credibility and/or relevance to the needs of local agencies, researchers and populations. These processes were thereby also perceived to lack legitimacy. This lack was compounded, on the one hand, by the research burden such activities placed on the resources and time of impacted communities, agencies and researchers, and on the other, by related tensions around interfaces between international and local research and national cultures, languages, norms and values. The picture that emerges is of an environment where the credibility, relevance and legitimacy of both socio-medical and physical science research endeavors come under significant pressure. Putting local operations and communities at risk, this pressure also risks the legitimacy of research endeavors.

1.3.2 Integrated, collaborative post-disaster research

It is notable that both large representative bodies frame this issue as the failure to collaborate effectively with local responses and research teams. The clear implication is that all research carried out in disaster impacted environments is in effect, whether actively or in ignorance, interacting with those communities, agencies and researchers already engaged in a collaborative response to the event. From a boundary management point of view, failing to collaborate effectively, in this context, is to compromise legitimacy by completely disregarding the needs of these involved stakeholders. Although not directly concerned with research activity as such, recent major humanitarian initiatives

have similarly argued that needs assessment and aid provision approaches in post-disaster environments must be as collaborative and integrated as possible with local authorities and communities (Walton-Ellery & Rashid, 2012; Brown & Donini, 2014).

Both the IAVCEI and the Working Group also make the case for such collaboration as an imperative. After disasters, all researchers are or should be required to collaborate with local research and operational response teams. The IAVCEI subcommittee for crisis protocols articulates this as an overriding directive: volcanologists must at all times defer to “the primary jobs at hand: to use and improve the science for public safety and welfare,” and that this can only be achieved in collaboration with (and by deferring to) local response agencies, and the local team of volcanologists given the primary responsibility for the direction and outcome of a crisis response (p. 323, Newhall et al. 1999). This directive was challenged at the time on the grounds that requiring scientists to consider the needs of the local response and the communities they serve amounted to undermining scientific credibility, and undervaluing research carried out by volcanologists not aligned with the hazards team (Geist & Garcia 2000). Indicating the guidelines have been interpreted as a direction to subordinate concern for scientific credibility to the relevance requirements of responding agencies, this response underlines the tensions that have inhibited collaboration in past disasters. Detailed IAVCEI protocols require visiting researchers to contact and arrange research collaboration prior to arrival, to come only if invited by the local team, and go on to detail appropriate professional conduct when interacting (in different scenarios) with local researchers, agencies, communities and media, and each other. The same themes inform the ethical guidelines for conducting post-disaster research in developing countries set out in the Asian Bioethics Review special issue by the fifteen-member Working Group. Applying the distributive justice and beneficence principles of the Belmont Report to the wider post-disaster research environment, Sumathipala et al. (2010) produce guidelines consistent with, and designed to supplement, accepted national and international ethical guidelines. They include requirements for culturally sensitive research to be carried out in collaboration with local researchers and communities, for research to

prove that it is essential (not possible in other conditions), that it is relevant and responsive to local needs, and that it will not disrupt or further burden existing infrastructure (Sumathipala et al. 2010).

The Working Group guidelines include higher level recommendations, moreover, calling for the establishment of a central/national mechanism responsible for all ethics review and research coordination in the disaster-affected area, and for managing a research clearing house on an open website. This recommendation is likely to have been informed by the third example of work that addresses the impact of post-disaster research on affected populations and response agencies, the best known documented example of a successfully integrated disaster research response of this kind. Within two days of the bombing of the Murrah Building in Oklahoma City by US nationalists in 1995, an integrated Disaster Health Study Group (the Health Study Group) made up of representatives from fifteen research and response organizations was set up to help steer a collaborative research coordination process (North et al. 2002, Quick 1998). It aimed to maximise data collection and research quality, while minimising the burden on impacted populations, and protecting survivors of the bombings (Quick 1998). After agreement, at the first meeting, to set up a data base for all bombing related research and other data, for both response and research purposes, the State Health Commissioner enforced this initiative by declaring "all disaster-related injuries to be reportable events requiring report to the Oklahoma State Department of Health" (p. 623, Quick 1998). Subsequent discussions with the Governor's performance team on how to improve interagency collaboration in disaster management led to a decree from the Governor, requiring "that all bombing-related research and educational activities be monitored and coordinated by appointed officials of the state" (p. 581, North et al. 2002, Quick 1998). The University of Oklahoma's (UO) Office of Research Administration was given overall responsibility for research coordination, while all research protocols had to be submitted to the UO Health Sciences Center Institutional Review Board for review and approval (Quick 1998). In addition to prioritising research likely to be of immediate use to response and recovery agencies, this body required all visiting researchers to be paired with relevant local scientists (North et al. 2002).

The Oklahoma collaboration is likely to have been significantly enabled by the localised nature and scale of the bombing's impact. As North et al. note (2007), moreover, quality research projects may have been excluded due to the mandate given to the ethics review panel. Even so, it does seem to have managed the post-disaster research environment in a way that avoided the type of issues documented by the IAVCEI and the Working Group. Plainly, this collaborative initiative featured the three institutional procedures found by Cash et al. (2003) to characterise successful boundary organizations. Official decrees by the Governor and State Health Commissioner enforced a high level of commitment to this boundary spanning initiative, and set up clear lines of accountability on either side of the boundary. In addition to constituting much of the collaborative process, the regular ongoing meetings of the boundary-spanning DHSG also facilitated the joint production of a number of boundary objects, including the official bombing-related database, a Research Registry, post-disaster research training seminars, standardised consent forms, and so on. Ensuring that the collaborative process was inclusive from the outset, this group continued to facilitate communication, translation and mediation functions. The outcomes of this process were a highly collaborative research network, integrated with local agencies, and a large body of scientifically rigorous data and findings (North et al. 2002, Quick 1998).

When considered together, this work indicates that the post-disaster research environment should be recognized as one dominated by the highly complex and urgent collaborative effort that begins immediately after the onset of the disruptive event, as local communities, agencies and researchers respond and adapt to its impacts. All research conducted within and/or concerning this impacted environment thus needs to be recognized as in effect a part of this wider collaborative effort – if more or less actively, and wittingly. Failure to recognize and collaborate effectively with this effort can greatly increase unproductive tensions between the scientific credibility, relevance (particularly to the needs of local agencies and researchers involved in response and recovery) and legitimacy of the research processes, at the expense of impacted communities, and 'research' itself (Sumathipala et al. 2010). Conversely, collaborative research

initiatives coordinated by local agencies and research organizations, and supported by proven boundary-spanning procedures have proved effective in managing these tensions (Quick 1998, North et al 2002).

By including the complex wider context within which such collaborations occur, boundary management approaches developed in the environmental management context may be more effective in researching, understanding and acting to improve the processes that effect such highly complex post-disaster research collaborative endeavors than those which are solely informed by narrower critical or ethics-based approaches. The debate around the ethics of research activities in the time-compressed post-disaster environment is thus also a reminder that the tensions that emerge so starkly in this context are to a greater or lesser extent fundamental to all research environments. Much social science research, for example, relies on access to data – and research participants – in the name of the public good (Collogan et al. 2004, Ausbrooks et al. 2009, Knack et al. 2006). The post-disaster context foregrounds an obvious but rarely stated fact – that where manifest benefits accrue to the researcher, those experienced by participants are less direct (Brown & Peek 2014). This is not usually expressly acknowledged in applications for ethics approval, or in discussions of the ethics of research activities. Equally, this environment raises related questions around research activities in the physical sciences. Since basic science is not usually understood to involve human participants, scientists are not usually trained to consider the wider ethical implications of research activities, even when they contribute directly to risk analyses, or are required to engage with local agencies and populations. It seems likely that the findings of this research project may thus also be applicable to the wider research environment, which – as a complex discursive system – is constituted of complex collaborative networks. Better understandings of the research processes involved may thus help manage tensions associated with scientific credibility, relevance and legitimacy more productively, in the basic, as well as applied science areas.

1.4 Case study context

1.4.1 New Zealand hazard management

The Canterbury earthquake sequence occurred at the end of a decade of change in New Zealand informed by a decentralizing, deliberative and integrated national approach to both managing and researching natural hazard and disaster risk (Johnson & Mamula-Seadon 2014, Helm 1996, 2009, Smith 2009). This approach has been explicitly informed by growing awareness of the risks posed by cascading interactions between the intricately linked sets of complex systems that make up the physical and social environments (Helm 1996, 2009). The earlier Crown Research Institute (CRI) Act 1992 and the Earthquake Commission (EQC) Act 1993 both regulated for the provision of hazards research in the national interest. In 2002 the Civil Defence and Emergency Management (CDEM) Act built on these and other legislative changes to shift national hazard management “from centralized, rules-based, response organizations towards more flexible arrangements based on principles, culture, mitigation and local knowledge” (p. 70, Helm, 2009). This was explicitly articulated as part of a new, systems approach to the management of unpredictable complex system dynamics, designed to move away from a prime focus on hazards (as the source of problems), towards the management of the total “Source-Community” system (p. 69 Helm, 2009; Helm 2014). On the one hand, resulting measures were designed to devolve responsibility for disaster mitigation and response to local level, and to greatly increase horizontal networking at that local level, with a view to enhancing the resilience of linked social, physical and environmental networks (Helm 2009). ‘Resilience in this context has been defined as a function of situation awareness, management of keystone vulnerabilities and adaptive capacity in a complex, dynamic and interconnected environment (McManus et al. 2007). On the other, this wider strategy was supported by a top-level centralized system for national security management known as Domestic and External Security Coordination (DESC). Developed to enable the ‘fast, flexible, adaptive management of all national security issues,’ including ‘all hazards’ (Helm 2009), this top down, command and control mechanism was designed to make it possible for

governments to respond tactically to challenges 'as they arise' (p. 69, Helm 2009). Effecting a whole-of-government approach to security, the ODESC system was also tailored to facilitate the coordination of devolved sectoral and regional capabilities where a rapid national response is required (Helm 2009).

In emergency management terms, the goal was, and is, improved situation awareness. When used in its widest sense, this term refers to a quality of the wider system, its overall ability to comprehend elements in any present situation and project their effects into the future (McManus et al. 2007). Effective situation awareness requires highly networked systems, and the effective utilization of these networks in response to disruptive events. Facilitating a focus on risk mitigation, and the identification and minimization of vulnerabilities, this wider situation awareness also increases the systems capacity to adapt effectively to major events. In recent international disasters, limited situation awareness has led to major deficiencies in emergency response (Van de Walle & Turoff 2008, McManus et al. 2007). Effective emergency response requires what Stanton et al define as 'distributed situation awareness:' the 'dynamic and collaborative process binding agents together on tasks' and in time in response to an emergency (Stanton et al. 2006). Since this relies on the extent to which the relevant system is already highly networked, distributed situation awareness during an emergency response is to this extent a function of the overarching situation awareness that already exists in the system. (McManus et al. 2007, Stanton et al. 2006). Leading to a change in focus from 'post-crisis response to pre-crisis planning,' this recognition has informed initiatives designed to increase horizontal and vertical linkages in hazard and emergency management networks, actively engaging stakeholders, organizations and government in order to foster ongoing communication and collaboration.

The CDEM Act (2002), for example, requires and sets out the conditions for collaboration between District, Regional and National levels of government during emergencies, and (at each level) between government and first response organizations, including the police, the army, and private lifeline providers (CDEM Act 2002). The aim was to improve horizontal networking between District and

Regional councils. Established under the Local Government Act and the Resource Management Act, respectively, District and Regional councils have evolved historically as parallel, rather than integrated structures, loosely linked, with significant overlap in several areas. As Glavovic et al. (2010) point out, aspects of the relationships between these levels of government, and their respective responsibilities for hazard management are still not clear, despite the clarification provided by the CDEM Act.

The CDEM plan, required under the Act, has been explicitly designed to function as part of a linked set of plans, policies and legislation (Figure 2), reflecting the same drive to increase networking and collaboration between the organizations involved in hazard and emergency management (CDEM 2009).

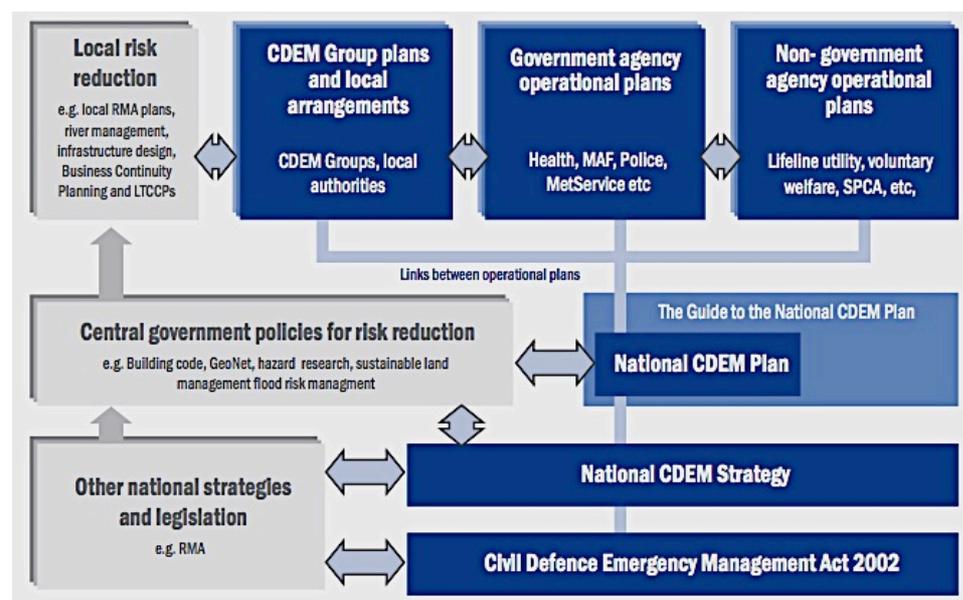


Figure 2: Relationship between the CDEM plan and other plans, policies and legislation as of 4th September 2010 (CDEM 2009).

The modular Coordinating Incident Management System (CIMS) structure, first introduced in the 2005 CDEM Plan, explicitly spells out the collaborative links and protocols between levels of government, and – at each level – between government and other organizations involved in emergency response. Detailing the highly specific project management structure to be used during emergency response situations (Figure 3), the CIMS system also requires that those involved

in such responses meet regularly, to train, plan and conduct exercises together. In this way it incorporates a regular collaborative requirement, attempting to create networks and so lay the groundwork for future emergency responses (Helm 2009). Thus the CDEM act is designed to involve individuals, families, communities, and private organizations, as well as government organizations, in the task of building resilience to the impacts of natural and other hazards (McManus et al. 2007).

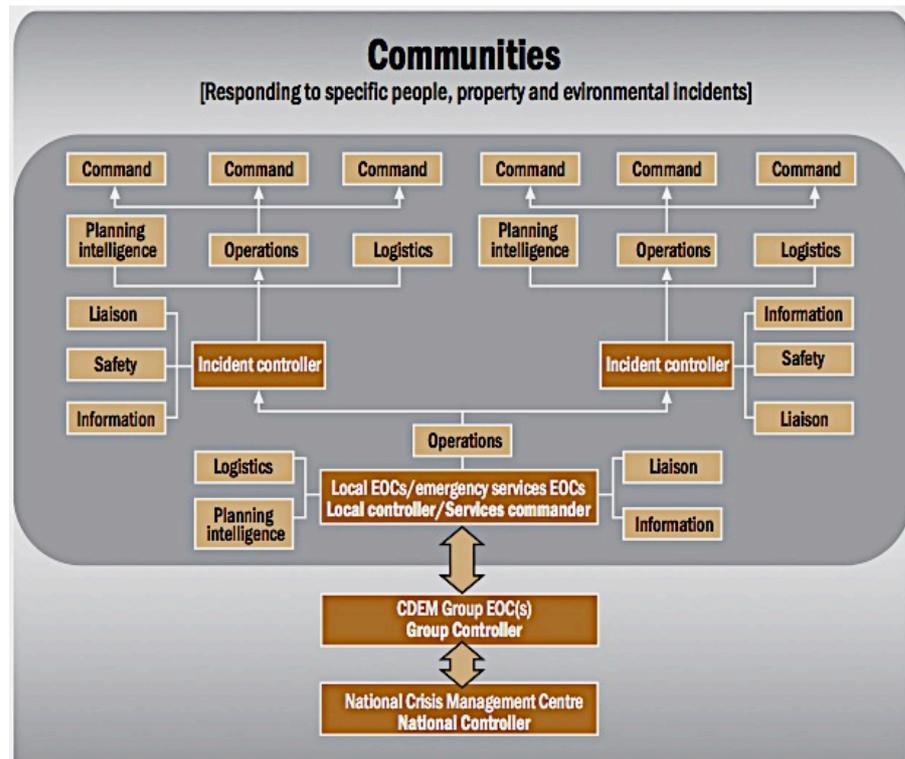


Figure 3: Multi-incident CIMS structure & interface for CDEM coordination as at 4th September 2010 (CDEM 2009). Note that the diagram inverted the usual hierarchy by putting communities at the top, to underline the devolution of responsibility to local levels.

1.4.2 Research advice and Coordination: CRIs and the NHRP

GNS Science (GNS) and National Institute of Water and Atmospheric research (NIWA) are Crown Research Institutes with statutory responsibilities under the 1992 CRI Act for providing science advice to New Zealand government agencies. The 2005 CDEM Plan awarded these organizations specific responsibilities for providing science advice to agencies involved in emergency response and recovery operations.

Recognition, in 2007, that a highly competitive research environment was significantly inhibiting research collaboration in New Zealand led to related initiatives aiming to build collaborative research networks by developing collaborative hazard and disaster research clusters (Smith 2009). As a first step in changing funding channels to provide more incentives for collaborative engagement with both end-user agencies and other research organizations, the then-Ministry of Research, Science and Technology (MRST) worked with EQC and CDEM to develop the multi-stakeholder NHRP. Set up by Ministerial directive, the NHRP framework consisted of research and advisory groups linked primarily by a series of contracts (Figure 4).

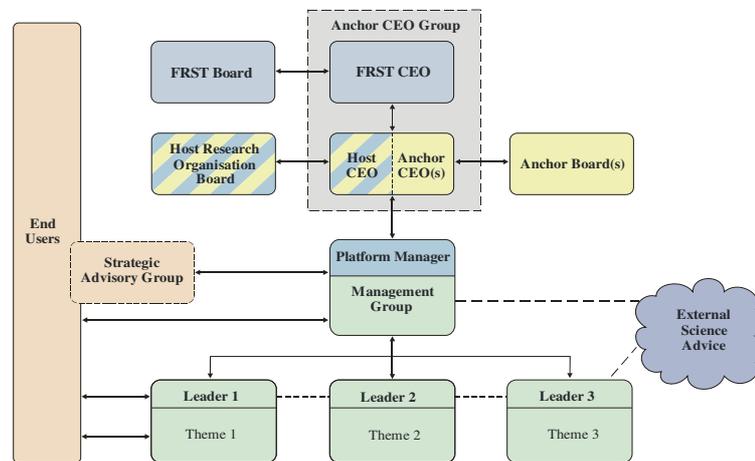


Figure 4: Founding management structure of the Natural Hazards Research Platform (NHRP 2009B).

GNS Science, the Host Research Organization (with existing responsibility in this area, and chosen through a tender process) collaborates with the other CRI Anchor organization (NIWA) and organizations contributing under subcontract to strategically identified research theme areas (Figure 5). The NHRP was designed as the first step in developing a more integrated and collaborative research and funding environment in New Zealand, by building connections across agencies and disciplines, and between research providers and end-users. The aspiration was to enhance the adaptive capacity of a networked research and hazard management community, and so contribute to the larger strategic aim of building

a New Zealand society that is more resilient to natural hazards (NHRP 2009A) (Figure 5).

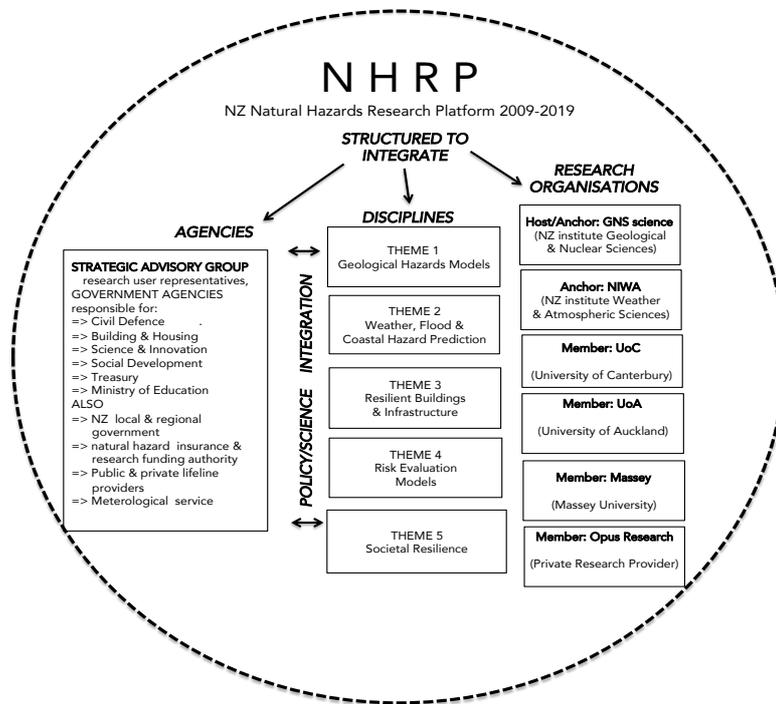


Figure 5: Natural Hazards Research Platform structure, integrating organizations, disciplinary 'theme' areas and stakeholders

While the overall emphasis of the Interim Research Strategy document was on the coordination of research funding and activities to inform hazard management policy and decision making, it also required that, during significant hazard events, the NHRP was to ensure the provision of science capability 'to assist decision makers' (NHRP 2009A). Thus when the Darfield earthquake initiated the Canterbury earthquake sequence on the 4th September 2010, it was to provide a major challenge for the NHRP. In place for less than six months, and based on an Interim Strategy, it had not had time to develop systematic guidelines as to the nature and management of collaborative relationships, and its role in coordinating research collaboration for the purposes of emergency response had not become clear.

1.4.3 The Canterbury earthquake sequence

The Canterbury earthquake sequence was also to pose the first real test of the new, more devolved, networked and adaptive approach to hazard management in New Zealand. It began on 4 September 2010 with the M_w 7.1 Darfield earthquake. The epicentre was 10 km deep and ~35km west of Christchurch, New Zealand's second largest city (pop. 390,300 as at June 2010 <http://www.stats.govt.nz/>). Ground shaking resulted in widespread liquefaction in eastern Christchurch, and caused ground, building and infrastructure damage (Cubrinovski et al. 2010; Bradley et al. 2014). This was the first in a sixteen-month sequence of earthquakes that trended eastwards across Christchurch, punctuated by a further three large earthquake events which caused significant additional damage (Bradley et al. 2014) (Figure 6).

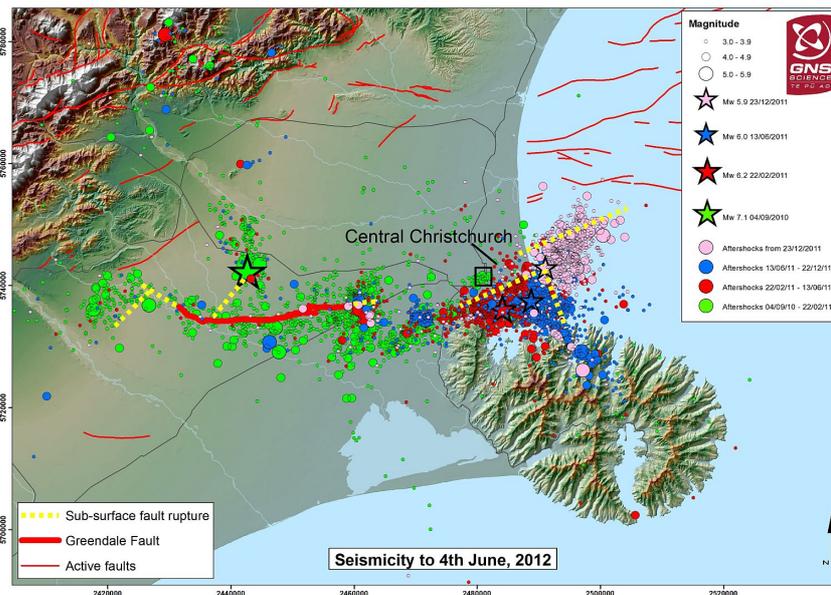


Figure 6: The Canterbury earthquake sequence from 4th September 2010 – 4th June 2012

The second, and most damaging of these larger earthquakes, occurred on 22 February 2011, when the M_w 6.2 'Christchurch Earthquake' led to 185 deaths and more than 6,500 injuries (Johnston et al. 2014). Originating 5 km under the city's southern suburbs, only 6 kilometers away from the city's central business district, unusually high vertical accelerations caused extensive liquefaction and associated ground and building damage (Chang et al. 2014). Partial or total building collapse

during this event caused 175 of the 185 deaths; 133 resulted from the collapse of two large multi-story buildings in the central business district (Cooper et al. 2012). The Darfield earthquake had been coordinated at the regional level. The scale of the disaster caused by the Christchurch earthquake, and the magnitude of the required response and recovery operations, led to the declaration of the first state of national emergency in New Zealand, on the 23rd February 2011, which lasted until the activation of the Canterbury Earthquake Recovery Authority (CERA) on the 1st May 2011. A purpose-built central government agency of limited duration, CERA was tasked with managing the overall recovery strategy, and given a range of powers designed to reduce obstacles to recovery decision-making (Johnson & Mamula-Seadon 2014). The third and fourth of the larger events, on 13th June (M_w 6.0) and 23rd December 2011 (M_w 5.9), respectively, were less disruptive, although they significantly compounded liquefaction and damage effects (Bradley et al. 2014, King et al. 2014). This article uses Canterbury Earthquake Sequence (CES) when referring to the larger, cumulative earthquake disaster.

Damage to older buildings and facades in the central business district after the Darfield earthquake informed the decision to cordon off a significant proportion of the city center for safety reasons for a week, from 4-10 September (Chang et al. 2014). After the 2011 Christchurch earthquake, damage to the ~2,000 commercial buildings in the CBD was so extensive that the entire 349 hectare district bounded by the city's four central avenues was cordoned off as a red zone (Chang et al. 2014). Although progressively reduced in size, a substantial cordon manned by the NZ Defence Force remained in place for more than two years, from 22/2/2011 to 30/6/2013 (Chang et al. 2014, McGregor 2013). More than half the commercial buildings in the CBD have been demolished, including a significant proportion of the city's heritage buildings (Cooper et al. 2013, Chang et al. 2014). A large majority of residential buildings also sustained damage, as evidenced in more than 500,000 residential insurance claims for earthquake damage to buildings, land and contents from approximately 160,000 dwellings, as well as 30,000 non-residential insurance claims (King et al. 2014).

The dominant cause of building damage was widespread liquefaction ground

damage throughout central and eastern suburbs, particularly in the Christchurch earthquake (Cubrinovski et al. 2011, Bradley et al. 2014). Liquefaction also caused severe damage and disruption to road networks and aging, buried infrastructure networks, compromising water, electricity and sewage systems (Rogers et al. 2014, van Ballegooy et al. 2014). The extent and range of land damage caused by liquefaction and slope instability in some areas of the city was such that in 2011 the decision was made to categorize over 7,500 residential properties (~5% of total housing stock) as too difficult, uneconomic, dangerous and/or impractical to repair (Chang et al. 2014, Rogers et al. 2014). Those with properties zoned red on this basis were able to engage with a Government offer process, which provided eligible homeowners in these zones with the opportunity to relocate (Rogers et al. 2014).

The total cost of recovery and reconstruction has been estimated at as much as NZ\$40 billion, which is equivalent to around 19% of New Zealand's GDP (New Zealand Treasury 2013, cited by Stevenson et al. 2014).

Rather than coordinating the response to the Christchurch Earthquake from the National Crisis Management Center in Wellington, as specified in the CDEM plan, the National Controller and some National Crisis Management Center staff did so on location in Christchurch, based together with the CDEM Group and Christchurch City CDEM teams in a specialized Christchurch Response Center. The NHRP staffed a science desk in the Christchurch Response Center, and teams made up of local and international (academic and consulting) engineers, geotechnologists and geologists conducted coordinated seismic, damage and risk assessment programs across the city in support of the response. Concern about mounting research pressure on local researchers, agencies and communities led the National Controller to consult with the NHRP and others concerning a moratorium declaration, which was focused in particular on all active social science research engagement with impacted communities that was not directly contributing to response operations, throughout the national emergency period (NCMC Log 2011, McLean et al. 2012)..

SEPTEMBER 4th 2010

M7.1 'Darfield' earthquake hits Canterbury. Local states of emergency declared.



SEPTEMBER 16th 2010

State of local emergency lifted by Christchurch Mayor

DECEMBER 26th 2010

M4.9 'Boxing Day' earthquake



FEBRUARY 22nd 2011

M6 'Christchurch Earthquake'



FEBRUARY 23rd 2011

State of national emergency declared

MARCH 11th 2011

Declaration of Social Science research moratorium by National Controller

APRIL 30th 2011

State of national emergency lifted
Social science research moratorium lifted.

JUNE 13th 2011

M6.3 earthquake



DECEMBER 23rd 2011

M5.8 followed by M6.0 earthquakes.



SEPTEMBER 6th 2010

Gerry Brownlee appointed Minister for CER; Cabinet Committee on CER formed.

SEPTEMBER 14th 2010

CERR Act enacted; CERC established.

MARCH 11th 2011

Psychosocial Recovery Advisory Group established

MARCH 14th 2011

Royal commission of inquiry established.

MARCH 24th 2011

CERA announced publically.

APRIL 14th 2011th

CER Act enacted.

MAY 1st 2011

Recovery process transferred to CERA.



Figure 7: The Canterbury Earthquake Sequence timeline, showing key events (adapted from Brookie, 2012)

In May 2011, the government passed the CER Act. The Act vested strategic responsibility for the recovery in a purpose-designed authority, based, like the national response, in Christchurch, and to include representatives from all relevant government agencies (Johnson & Mamula-Seadon 2015). This authority was a

departure from the recovery arrangements specified in the CDEM plan, and it again reported to the Minister for the Recovery, the Minister of Economic Development, rather than the Minister of internal affairs.

This research project was primarily concerned with the major response and recovery operations that followed the Darfield and Christchurch earthquakes (Figure 9). It was focused on the engagement of the NHRP and its offshoot advisory group, the Psychosocial Recovery Advisory Group, with the sequential departures from existing CDEM plans established in response to the scale of the destruction caused by the Christchurch earthquake.

1.5 Thesis Organization

The chapters that follow build a sequentially layered picture of the research response to the Canterbury Earthquake Sequence, in relation to both the aims of this project. Although all are concerned with this research response, each chapter has a different focus, and is concerned with a different time frame. The chapters become progressively more closely focused on the NHRP and more explicitly theoretical. Each chapter begins by briefly rehearsing (and to a small extent repeating) relevant aspects of the larger context discussed in this first chapter, as required for the discussion that follows, in the interests of clarity. Chapters three (Research coordination after the 2010-2011 CES) and five (Boundary organizations after disasters) have both been submitted for publication. They are largely reproduced in this thesis as submitted, although efforts have been made to reduce obvious repetitions.

Chapter two provides a wider context for the case studies that follow it. A bibliometric analysis compares a data set of publications concerned with the Canterbury Earthquake Sequence with data sets of publications concerned with three other recent disasters. This contextualization was deemed necessary because of the limited comparative context. Existing literature provides only one other case study of the use of a large research coordination body to coordinate research support for agencies after disasters, and there are few options available

for assessing and comparing research activity between different disasters. In this chapter's bibliometric analysis a research publication field linked by name to the 2010-2011 CES is compared with those in fields concerned with the 2005 Hurricane Katrina disaster, the 2009 Black Saturday Bushfires Bushfire disaster, and the 2010 Haiti Earthquake. Metadata is used to compare levels of affiliation to international organizations, to agencies and levels of items that fall into the broad Science, Technology, Engineering and Math (STEM) category (as defined by Bastow et al. 2014). The findings of this chapter contextualize the case studies that follow in two ways. Firstly, they indicate that levels of agency affiliation to publications are broadly consistent across all four disasters, and consistently higher than those identified in a recent bibliometric analysis of a very large sample of current disaster risk reduction literature. This is consistent with the limited (although seminal) findings indicating that the post-disaster environment can stimulate integrated research activity, suggesting this effect may be linked to factors common to all post-disaster environments. Secondly, they indicate proportional disaster impact as a likely factor in variations in international affiliation levels, which were higher in the Canterbury Earthquake Sequence and Haiti Earthquake data sets, and highest in the Haiti Earthquake publication field. High levels of affiliation density to a few national research organizations were characteristic of data sets concerning disasters in developed countries, and highest in the Canterbury Earthquake Sequence data set. Mixed international and national affiliation levels were also highest in the Canterbury Earthquake Sequence data set.

These findings contextualize the case study in Chapter three, which is focused on the research risks and opportunities arising in the immediate aftermath of the Christchurch Earthquake, and so concerned with research activity during the state of National Emergency, which was declared the day after this earthquake on 23rd February 2011, and lifted on April 30th. The boundary management framework is used to analyze the NHRP's coordination of research in support of the two month response operation over this period, focusing on the logistical and ethical issues created by the urgency and time-compression of this environment, international and national research pressure, and the effects of shared perceptions concerning

the parameters of both this organization and its operation. It finds that the NHRP was effective in bringing the resources of its member organizations, and the associated national and international networks, into a larger research operation in support of agency decision-making. Perceptions of exclusion however were created by attempts to manage the risks arising out of research pressure, and by widespread erroneous assumptions about the NHRP's role, giving rise to new risks to legitimacy. Lessons drawn from this analysis include the necessity of the joint management of the risks associated with research pressure after disasters through a collaboration between response agencies and research communities, the value of using an inclusive research coordinating platform or organization in such collaborations, the need to ensure that it is responsible for all research activity in the impacted region, and the importance of ensuring that coordinating arrangements are transparent and widely disseminated. The chapter also recommends the use of an existing structure, with a permanent national research coordination function. It concludes by reiterating calls made elsewhere for more awareness of the risks associated with research pressure after disasters, of the need for research communities to respect moral and ethical principles, and of the importance of being guided by the needs of local response operations, researchers and impacted populations. (This chapter has been published in the journal *Earthquake Spectra*).

The decision-making framework that informed Chapter Three is explained in more detail in Chapter four, where it is applied in a case study of the Psychosocial Recovery Advisory Group (PRAG), a small advisory group established by the NHRP. This case study is focused on the transition from response to early recovery in the 18-month period after the earthquake, and the associated changes in agency demand indicated by this group's caseload over this period. The chapter finds that the initial scope, function, membership and geographical parameters of this Advisory Group reflected agency need, immediately after the event, for rapid commentary from existing Wellington contacts with disaster specialization. As the recovery operation developed in Christchurch, and agency focus shifted onto the need for knowledge concerning recovery from this disaster, the limiting effects of these early parameters made it difficult for this group to adapt. Lessons include

the need to anticipate both the early reliance on existing knowledge, networks and specialist capacity, and the subsequent shift of focus onto the development of new knowledge, networks and capacity, by ensuring that the parameters of organizations facilitating research support for agencies are as flexible as possible. The chapter also notes the utility of the boundary organization framework focus on the effects of decision-making concerning organizational parameters in the post-disaster context.

Chapter five reverses the emphasis of earlier case studies, by using a case study of the NHRP as a boundary organization to test the utility of the boundary organization concept in the disaster risk reduction context. The foregrounding of the framework's utility makes this the most explicitly theoretical chapter. The analysis assesses the impact of the Canterbury Earthquake Sequence on the wider performance of the NHRP during its first five years of operation. The framework is used to map the NHRP's collaborative arrangements in relation to boundary tensions over time, distinguishing pre-existing and ongoing structural effects from the effects of the disaster. Key findings are that the NHRP was largely based in the research domain, and so was well placed to resist the negative pressure of post-disaster time compression on research quality. This left it less well placed to resist the impact of this environment on the networking required to integrate disciplinary, organizational and higher level science/policy domains, and so increase the legitimacy of the larger collaboration. Five points are made concerning the utility of the boundary organization concept as a schematic template. It requires attention is paid to striving for balance between domain drivers, engagement and between organizational parameters. It provides the breadth of perspective facilitated by the emphasis on assessing the relevant organization in relation to wider domains, and brings social, political and cultural contexts into view. It is focused on system effects that create self-similar patterns at smaller and larger scales, affording a flexible focus, and facilitating a nuanced, layered perspective. Lastly, the focus on effects, patterns and trends, rather than individual or organizational performance serve as a valuable counterweight to the destructive blame attribution common after high profile disasters.

Chapter six provides concluding comments linking the key findings from the project to the project aims, drawing out implications for current and future disaster risk reduction trends.

1.5.2 Materials

This project is primarily reliant on the large range of secondary material available after the CES. It also draws from the observations and knowledge of the author, her supervisory team, and others who were involved in different capacities in aspects of the response, recovery and NHRP operations that are the subject of the analyses.

Post-disaster research integration:
indications of stakeholder engagement
and international involvement
in publications after four recent disasters

2.1 Introduction

Disasters are officially defined in relation to levels of disruption and losses that overwhelm the ability of impacted communities and society to function (UNISDR 2009). The scale of this disruption catalyzes an immediate spike in demand for information and decision-making, and high levels of focus across domains and sectors (Olshansky et al. 2012, Johnson & Mamula-Seadon 2014, Birkland 1998, 2009). Such environments have been found to trigger increases in research funding and activity, greater likelihood of science/policy collaboration and the uptake of science by policymakers (Gall et al. 2015, Liu et al. 2012, Birkland 1998, 2009, Taskin 2010). Escalations of research activity after disasters have also been linked to increased risks to research quality, however, and been identified as an additional burden on regions struggling to function after the disaster (Birkland 2009, Newhall et al. 1999, Sumathipala et al 2010, Citraningtyas et al. 2010, Brown & Donini, 2014, Walton-Ellery & Rashid, 2012, Brun 2009, Gill et al. 2007). Existing literature has also indicated that the integration of research activity into the larger collaborative response to the disaster event has the potential to reduce such risks and enhance some of the opportunities generated by this environment (Newhall et al 1999, Sumathipala et al 2010, Citraningtyas et al. 2010, Black 2003, North 2002).

This larger doctoral project uses research coordination and response after the 2010-2011 Canterbury Earthquake Sequence as a case study, to gain a better understanding of the role of knowledge domain boundary tensions in this particular post-disaster environment. Case studies provide a more detailed understanding of a phenomenon of interest, although as a single instance cannot

be used as the basis of generalized empirical knowledge (Stake 1995). Existing findings concerning post-disaster risks and opportunities, and the use of national research coordination bodies to manage them provide valuable comparative context, by contextualizing and so considerably increasing the understandings provided by this case study.

Although the existing literature in the area discussed in the introduction does indicate that more detailed understanding of this phenomenon is required, this material is limited, making it difficult to situate research activity after the Canterbury Earthquake Sequence alongside that which has occurred after other disasters. Publications concerning the Disaster Health Study Group established in the immediate aftermath of the 1995 Oklahoma City bombing in the United States amount to the only relevant case study involving the use of a science/policy boundary organization to coordinate post-disaster research (North et al. 2002, Quick 1998). Literature focused directly on post-disaster risks and opportunities includes Birkland's seminal body of work focused on the risks and opportunities relating to the quality and integration of disaster risk reduction research and policy in the aftermath of US disasters, and two guideline documents by representative panels from different disciplinary fields based on reported evidence of the risks international research pressure has posed to disaster-impacted response agencies, communities and researchers (Birkland 1998, 2005, 2009, Newhall et al. 1999, Sumathipala et al. 2010). Several recent bibliometric studies have also indicated that specific disasters have stimulated research activity (Gall et al. 2015, Liu et al. 2012, Taskin 2010), while a 2006 National Academy of Sciences synthesis study found that disaster events have played a role in increasing historically low rates of social science involvement in disaster risk reduction (NAS 2006).

The high proportion of synthesis and bibliometric studies in this sample is consistent with the limited range of tools available for research domain assessment; this has contributed to a corresponding lack of information concerning integration in the broader hazard and disaster risk management field (Johnson & Hayashi 2012, NSF 2006, Few & Barclay 2011, Hackmann et al. 2013, Gall et al. 2015). Recent analyses of bibliometric disaster risk reduction and

earthquake research data sets are of particular value, in that they have helped to clarify the shape and general focus of related publication fields (Gall et al. 2015, Taskin 2010, Liu et al. 2012, Li et al. 2009). They thus provide both a precedent and context for this chapter, which reports a comparative bibliometric analysis comparing the shape and distribution of a Canterbury Earthquake Sequence publication field with fields related to three other recent disasters: the 2005 Hurricane Katrina disaster in the US, the 2009 Black Saturday Bushfires in Australia, and the 2010 Haiti Earthquake.

The analysis was designed to build on and contribute to existing work concerned with post-disaster research opportunities and risks, and so further contextualize the understandings provided by this doctoral case study. Bibliometric data was used to derive broad indications of integration across organizations, disciplines and sectors, of relative proportions of social science activity, and of levels of national and international engagement. The aim was to compare patterns of findings across examples of recent disasters that differ in type (earthquake, bushfire, hurricane), and location (New Zealand, Haiti, Australia, United States). Indications of collaboration (between organizations, disciplines, and nationals and internationals) were used as a proxy for integration. Web of Science (WoS) was used to collect items published within four years of each disaster.

The comparative bibliometric analysis presented and discussed in this chapter also drew on and contributes to the limited body of work concerned to establish broad levels of integration in the general disaster risk reduction domain. Recent nationally commissioned United States and United Kingdom synthesis studies relating to disaster-related social sciences have found little integration between physical and social branches of science (NAS 2006), and that stakeholder integration remains scarce (Few & Barclay 2011). A steady increase in multiple authorship in most disciplinary fields has been observed over the last twenty years, particularly in STEM categories (Corley & Sabarwal 2010, Glänzel 2002, Porac et al. 2004), and recent findings concerning global disaster risk reduction and earthquake research publication fields indicate that multiple authorship has also increased in these fields (Liu et al. 2012, Gall et al. 2015). Although indicating

a limited increase in multi-disciplinarity over the last decade, these studies found little evidence of integration when it came to more disparate disciplinary fields and methodologies (Liu et al. 2012, Taskin 2010, Gall et al. 2015). Researchers from developed countries are responsible for the majority of publications in both disaster risk reduction and earthquake research areas, even when publications are based on research activities conducted in other parts of the world (Gall et al. 2015, Liu et al. 2012).⁶

2.2 Methodology.

The analysis provided context for a recent disaster in an English speaking nation; this, together with the focus on integration informed an emphasis on recent disasters in English speaking nations, where such research might be expected to be more accessible to policy and decision-makers. The search was limited to English language articles. Four disasters were included in the analysis: the 2010-2011 Canterbury Earthquake Sequence, New Zealand, the Black Saturday Bushfires that occurred in Australia in 2009, the Haiti Earthquake in 2010, and Hurricane Katrina, which impacted southern United States coastline in 2005. Three of these disasters were roughly comparable in relation to fatalities and losses proportional to national population and gross domestic product (GDP), and occurred in English speaking developed Pacific countries (Figure 1). The United States has produced the largest volume of disaster research publications, and Hurricane Katrina tops the five most heavily researched disasters in the English language (Gall et al. 2015, Liu et al. 2012). Thus the inclusion of this domestic US disaster offered a basis for comparison with disasters in developed countries with less internationally active research communities (Liu et al. 2012, Gall et al. 2015).

⁶ Note that the value offered by the analysis that follows lies in the comparison it is able to provide between the shape and distribution of publication data sets that have been gathered in the same way, concerning different disasters. This means that it is restricted to comparing the extent of integration as represented by these limited publication data sets, and cannot provide a more comprehensive indication of the extent of integration indicated by all research publications

Disaster name & year	Fatalities	National pop that year (millions)	Fatalities: % national pop	Total damage & losses (millions US\$)	Total annual GDP that year (millions US\$)	Losses: % GDP
Hurricane Katrina 2005	1,833	295.520	0.001	108,000	13,100,000	0.824
Black Saturday Fires 2009	173	21.875	0.001	4,400	926,700	0.475
Haiti Earthquake 2010	220,000	9.896	2.223	7,804	6,623	117.832
Canterbury Earthquake Sequence 2010-2011	185	4.403	0.004	21,000	163,800	12.821

Table 1: Comparative fatalities (as proportion of national population) and economic losses (as proportion of total annual GDP the year of the disaster) as indicators of level of disaster impact (Sources include <http://www.stats.govt.nz/>; <http://www.abs.gov.au/>; <http://www.multpl.com/united-states-population/table> (US Bureau Statistics); <http://data.worldbank.org/indicator/>; <http://www-wds.worldbank.org/>; Stevenson et al. 2013; Johnston et al. 2014).

The 2010 Haiti Earthquake is another of the five disasters most heavily researched in the English language (Gall et al. 2015; see also Liu et al. 2012). This is perhaps surprising, since French, rather than English, is spoken in Haiti. Haiti also differs from the other disaster locations in being a developing, extremely poor Caribbean island nation. The Haiti Earthquake thus afforded comparison between contemporaneous earthquake disasters in developed and developing small island nations. This event was also chosen because it marked the higher end of the disaster scale in terms of catastrophic impacts, as indicated in both fatalities as proportion of total population, and losses in relation to annual GDP (Table 1). Together these four disasters afforded diverse comparison between disasters caused by geophysical (i.e. earthquake) and climatic (i.e. wildfire and storm) hazard types, and include two (Haiti Earthquake and Hurricane Katrina) of the five recent disasters most heavily researched in English (Gall et al. 2015).

2.2.1 Data Retrieval

Web of Science (WoS), formerly the Institute of Scientific Information (ISI), is a citation database provided by Thomson Scientific. WoS remains the standard and most widely used tool for bibliometric analysis, and has been found to be the most accurate and consistent of available tools (Meho & Yang 2007, Waltman & Van Eck 2012). It was chosen as the sole database for this comparative study to maintain consistency across the data sets, and to allow for comparisons with other recent bibliometric research findings concerned with disaster risk reduction and

earthquake disaster research publications, which are also based on searches of WoS (and, in the case of historical publications, older ISI citation databases).⁷

Data was gathered through WoS searches using the name or names of the relevant disaster as found in keywords, titles and abstracts. Retrieved data was then manually cleaned of duplicate entries, and items that were either not concerned with the relevant disaster, or which lacked organizational affiliation details (see appendix below for more detail concerning search terms and processes). This resulted in 978 Hurricane Katrina entries, 407 concerned with the Haiti Earthquake, 192 Canterbury Earthquake Sequence entries, and 85 concerned with the Black Saturday Bushfires.

2.2.1 Content analysis

Content analysis consisted of manual coding of the WoS data sets to identify relevant research characteristics (place, stakeholder involvement, broad disciplinary category). The coding was based on data retrieved by WoS, including abstracts, and affiliation data. Much of the information (particularly concerning organization type) was not derivable from the data set, and required supplemental Internet research.

Organizational affiliation details retrieved through WoS were used as the main indication of the national origin(s) of the research author, and of national and international involvement in the research projects that informed the relevant publication (Gall et al. 2015). This nationality data was then used to code each citation in relation to the geographic location of the relevant disaster. Organizations affiliated with the relevant citation were coded as being either within the nation impacted by the disaster (N), or outside that affected nation (I).

⁷ WoS has, however, been found to be less capable of retrieving conference proceedings than some other databases (see Meho & Yang 2007 for the limitations of WoS). This means that the data sets gathered for the purposes of this study should not be taken as comprehensive representations of the field of research publications generated by each disaster.

Combined, these codes indicated the extent to which each output involved collaboration across more than one organization, and whether collaborations were within the impacted nation, between national and international collaborators or involved only internationals.

Each citation was also coded according to the type of author-affiliated organization, based on the extent to which the provision of research was the primary function of the relevant organization. Those with the provision of research as their primary function included tertiary organizations, national and international research institutes, not-for-profit research providers and think tanks (all coded 'R'), and private research consultancies (coded 'RP'). Organizations with primary functions associated with the provision of key government services were coded 'A', a category that included hospitals and armed forces as well as other national agencies and some branches of international governing bodies (such as the United Nations and the European Union). A third category included a range of non-governmental organizations, including large charitable and disaster relief organizations such as the Red Cross and other UN initiatives (such as the United Nations International Children's Emergency Fund), as well as local community initiatives (all coded 'NGO'). Finally, corporate organizations (including insurance providers, critical infrastructure, mining and other companies) that did not fall into any of the above categories were coded 'Corp'. Since the numbers of both NGO and Corp affiliations were low, they were included in an 'other' category. Again, it is important to reiterate that since many organizations fell into more than one of these categories, this coding was derived from the primary function of the relevant organization. *Médicins Sans Frontières*, for example, was coded as an NGO, although this organization also provides the key service provided by hospitals, which were coded (A). Similarly, research providers were coded R and hospitals A, although both can sometimes also be corporations, while teaching hospitals generate research as a significant secondary function. Collaborations that included 'other' organizations were also counted in the 'other category.'

Combinations of organizations affiliated with a single citation were taken as evidence of collaborations between those organizations. First authorship was used

to derive some indication of which organization took the lead, and gained most credit from the research publication. Again, this was a loose measure, particularly when considering the anticipated audience and purpose of each publication may influence the author order in cross-sector collaborative research publications, which are more likely to feature a researcher as first author than policy documents or NGO reports. Research conventions can also vary widely, with some disciplines (such as mathematics) listing authors alphabetically (Venkatraman 2010). There is emerging consensus, however, concerning the value accruing to primary authorship (Venkatraman 2010, Yukawa et al. 2014). Usually taken as an indication of the author with most responsibility for both research and writing, it is also valuable because of the visibility of the primary author's name when collaboratively authored work is cited (Yukawa et al. 2014, Venkatraman 2010). The number of items affiliated with each organization was also used as a broad indicator of the organizations most active after each disaster, while the ratio of organizations to items indicated the density of organizational activity in each publication field.

The disciplinary details provided by the relevant publication source were used to code each item in terms of a broad distinction between the physical and social sciences. Given the difficulty of clearly establishing such a distinction, the analysis relied on an existing categorization provided by Bastow et al. (2013), who include the physical sciences (including the medical sciences), technology, engineering, and mathematics groupings as a single category under the acronym (STEM). Items were coded as STEM, non-STEM or a combination of both. The social sciences, including economics, management and finance, policy, public administration and so on were thus coded non-STEM, as were the humanities and creative arts (Table 4: Appendix A). In instances where the details provided by the publication source were not definitive in terms of the STEM non-STEM distinction (such as 'Public health policy and services' & 'Multi-disciplinary'), individual article abstracts were used to categorize items.

2.3 Results

The analysis was concerned to identify patterns of affiliation that provided indications relating to the opportunities and risks related to research integration, and found to characterize the post disaster environment. Opportunities identified in the literature included a general increase in research opportunities, increased opportunities for collaborative science-policy integration leading to disaster risk reduction operations and policy, and opportunities to recruit social scientists into the historically STEM-dominated disaster-related research domain. The involvement of international researchers in such environments has also been found to increase opportunities to grow national research capacity and linkages into international research networks. High volumes of research activity, however, have been identified as posing risks to impacted communities and response agencies, particularly when they are not integrated into the collaborative response effort.

The findings are reported in two broad thematic categories. Organizational integration includes the involvement of stakeholder and national and international organizations. Disciplinary integration is concerned with the distribution of items in relation to broad disciplinary groupings.

2.3.1 Organizational integration

Organizational affiliation is based on authorship, and in this analysis collaborative authorship is used as a proxy for collaborative research activity. All four post-disaster data sets are consistent with identified trends concerning multiple authorship, in that the majority of items (between 76-90% of items) featured multiple authors, with slightly higher multiple authorship levels in STEM categories (from 86-92% of total STEM items were multiply authored).

Distributions of affiliated organization type were broadly consistent across all four post-disaster data sets. Between 70% and 82% of publications were research-only publications and between 89% and 96% of publications featuring some research organization affiliation (i.e., research only or research and agency), and only

affiliated this way (Figure 8). All featured correspondingly low levels of affiliation with other organizations, a category that included NGOs and corporations (Figure 8).

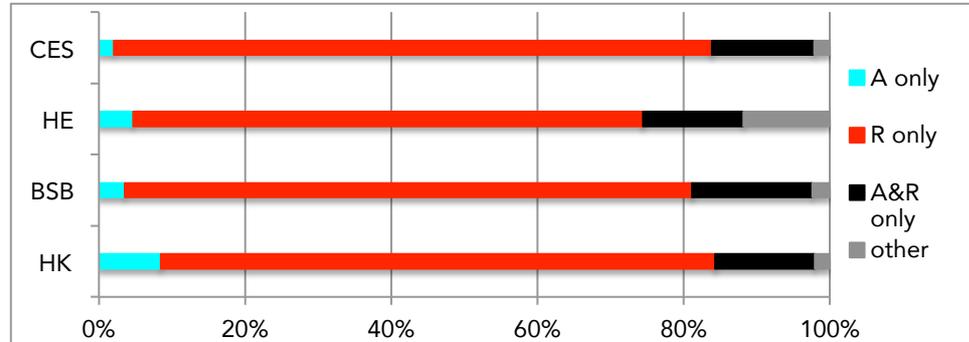


Figure 8: Involvement of government agencies (A) and research organizations (R) in publication data sets (as indicated by organizational affiliation with publications).

Levels of agency involvement in publications (i.e., A&R and A only inclusive) were above 16% for each disaster. Between 14% and 16% of publications involved authors with affiliations with at least one agency and one research organization, and between 2% and 9% were affiliated to an agency only. 16-25% featured affiliation with at least one agency.

A chi-squared analysis on the number of agency only, research only, research and agency and other publications as a function of disaster revealed a significant effect, $X^2(9) = 97.5$, $p < .0001$. Post-hoc tests ($p < .001$) revealed significant effects for each disaster except for the Black Saturday Bushfires data set and for each publication type except for the combined agency-research publications.

For the Hurricane Katrina data set there were more agency only publications and fewer other publications than expected. For the Haiti Earthquake data set there were fewer agency only and research only publications and more than expected other publications. For the Canterbury Earthquake Sequence data set there were fewer agency only, national only and more research-only publications than expected.

There were more agency only publications than expected for the Hurricane

Katrina data set and fewer than expected for the Haiti Earthquake and Canterbury Earthquake Sequence data sets. There were fewer research only publications than expected for the Haiti Earthquake data set and more than expected for the Canterbury Earthquake Sequence data set. There were fewer other publications than expected for the Hurricane Katrina data set and more than expected for the Haiti Earthquake data set.

Affiliation density indicated variations in the distribution of organizational activity in these data sets. Since most documents were affiliated to more than one organization, the ratio of organizations to documents indicated the overall affiliation density. The Hurricane Katrina data set featured the lowest ratio of organizations (712) to documents (978), at 0.7 organizations for each 1 document, indicating research activity more intensively focused through fewer organizations. Both the Canterbury Earthquake Sequence (197/192) and Black Saturday Bushfires (88/85) data sets featured ratios close to 1:1. The Haiti Earthquake data set featured the highest ratio of organizations (587) to documents (407) at 1.44, indicating research activity across a larger number of research organizations.

The organizations affiliated with the most documents in each data set provided a second indication of the intensity of organizational affiliation (Table 2). The Canterbury Earthquake Sequence, Black Saturday Bushfires and Hurricane Katrina data sets all featured considerably higher affiliation density to a few research organizations. The most highly affiliated organization in each of these datasets was linked to 35%, 26% and 10% of total items (respectively). In the Haiti Earthquake data set the three most highly affiliated organizations were each linked to only 4% or less of overall items, indicating less intensive affiliation to a few key organizations (Table 2). These differences appeared to be related to differences in the distribution of internationally and nationally affiliated organizations.

The three most highly affiliated organizations in the Hurricane Katrina, Black Saturday Bushfires and Canterbury Earthquake Sequence data sets were all large national research organizations (Table 2).

Affiliations to items as a percentage of the total number of items in each data set			
Data set	Highest	Second highest	Third highest
Canterbury Earthquake Sequence	University of Canterbury (NZ): 35%	GNS Science (NZ): 19%	University of Auckland (NZ): 14%
Haiti Earthquake	USGS (US): affiliated to 4%	University of Miami (US): affiliated to 4%	Center for Disease Control and Prevention (US): 3%
Black Saturday Bushfires	Monash University (Australia): 25%	University of Melbourne (Australia): 18%	La Trobe University (Australia): 8%
Hurricane Katrina	Louisiana State University (US): 10%	Tulane University (US): 8%	University of New Orleans (US): 4%

Table 2: Comparison between the three most highly affiliated organizations in each data set

Each of these three data sets featured a university centrally based in the relevant disaster impacted region with the most publication affiliations. By contrast, the three most highly affiliated organizations in the Haiti Earthquake data set were all based in the US. There were, moreover, only two national research Haitian research organizations affiliated to documents in this data set (the Université Etat Haiti – affiliated to 5 items/1% – and the Université Quisqueya – affiliated to a single item). This reflects lower overall national affiliation in the Haiti Earthquake data set, when compared with the other three data sets (Figure 9).

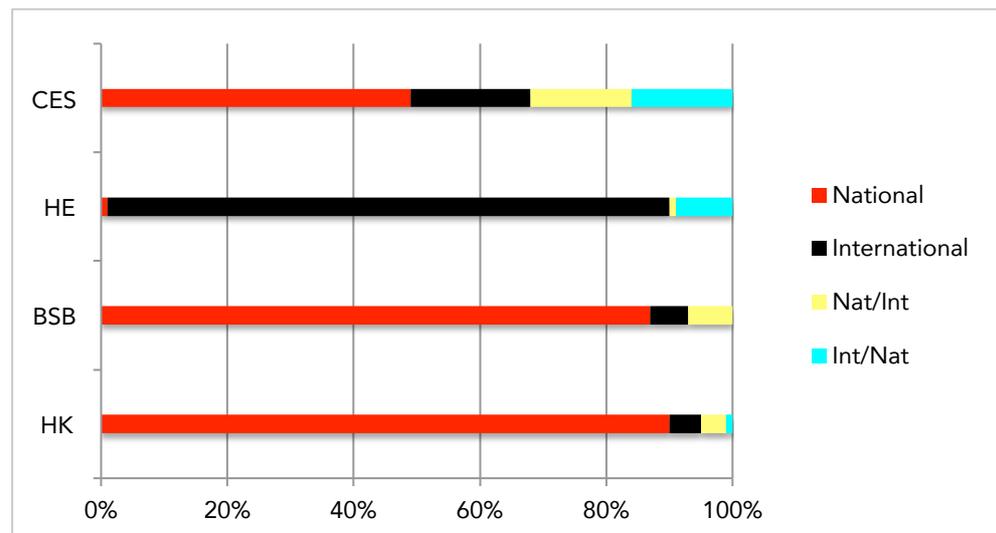


Figure 9: Involvement of national (N) and international (I) organizations, and national/international collaborations (as indicated by primary author affiliation).

In the Haiti Earthquake data set, 99% of publications were affiliated with international organizations, and 97% featured a first author from an international organization. Only 11% of the Haiti Earthquake publications involved Haitian organizations, and only 2% featured a first author from a Haitian organization (Figure 9). This distribution was reversed in the Hurricane Katrina and Black Saturday Bushfires data sets, which featured broadly similar levels of national and international involvement in publications (Figure 9). More than 90% of publications in each of these two data sets were affiliated with at least one national organization, and 94% of both data sets featured a first author affiliated with a national organization.

The Canterbury Earthquake Sequence data set falls between these extremes, with 65% of all Canterbury Earthquake Sequence related publications featuring a first author affiliated with a New Zealand organization (Figure 9). 49% of items were affiliated only with national organizations, compared with 90% and 87% of Hurricane Katrina and Black Saturday Bushfires items, and 2% of the Haiti Earthquake data set. 50% of Canterbury Earthquake Sequence publications featured some international involvement, compared with 99% of the Haiti Earthquake data set, and only 13% and 10% of Black Saturday Bushfires and Hurricane Katrina publications respectively.

Since all four data sets featured similar proportions of overall organizational affiliation (Figure 8 above), further analysis of the relation between organizational type and international and national affiliation was carried out (Figure 10). When analyzed according to organization type, both the Hurricane Katrina and Black Saturday Bushfires data sets feature low levels (7% or less) of international affiliation in items featuring collaborations between research organizations and agencies (A&R (Figure 10). At 41% and 27%, the Canterbury Earthquake Sequence and Haiti Earthquake data sets (respectively) appear to feature larger proportions of mixed international/national affiliation in this category (Figure 10).

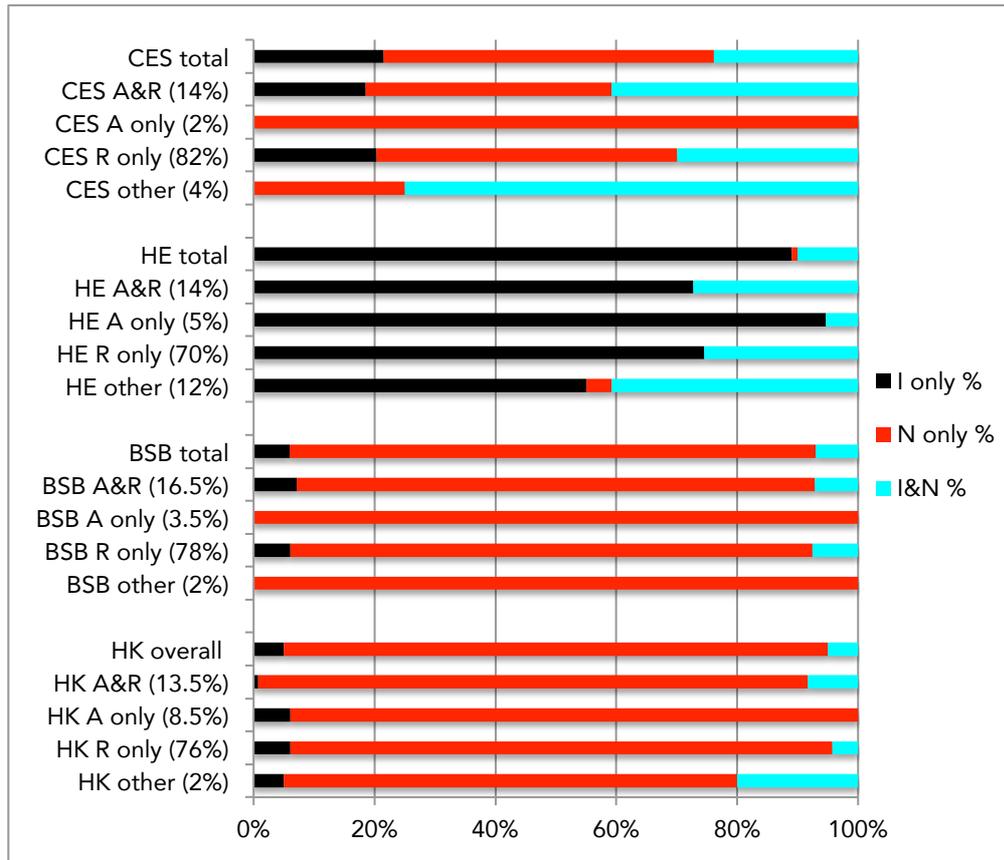


Figure 10: Distributions of national (N) and international (I) affiliation in relation to organizational type, comparing overall items with those affiliated to at least one agency and one research organization (A&R), to agencies (A), to research organizations (R), and to other.

A chi-squared analysis on the number of agency only, research only, research and agency and other publications combined across the data sets revealed a significant effect, $X^2(6) = 113.71, p < .0001$. Post-hoc tests ($p < .001$) revealed significant effects for national only and mixed national-international publications but not for international only publications, and significant effects for each type of organization.

For international only publications the number of each type of publication did not differ from that expected. For the national only publications there were significantly higher than expected numbers of agency only publications, and significantly lower numbers of research only and other publications than expected. For the national/international publications there were significantly higher than

expected numbers of other and agency/research publications but significantly fewer publications agency or research only organizations than expected.

For agency only publications there were fewer than expected international only and more than expected joint national/international. For research only publications there were fewer than expected national/international publications and more than expected both international only and national only publications. For agency/research publications there were fewer than expected international only and more than expected national/international publications. For other publications there were fewer than expected national only and more than expected national/international publications.

A separate chi-squared analysis was conducted for each of the 4 disasters, which revealed no significant effect in either of the Canterbury Earthquake Sequence or Black Saturday Bushfire data sets.

For the Haiti Earthquake data set, low levels of national affiliation meant that the comparison was only between international only and international-national publications. There was a significant effect, $X^2(3) = 88.90$, $p < .001$. For the international only publications there were higher numbers of research publications and lower numbers of agency/research and other affiliated publications than expected. For the international/national publications there were fewer affiliated to research organizations only, and more affiliated to agency/research and other organizations than expected.

For Hurricane Katrina the comparison excluded "other" publications, which were few. There was a significant effect, $X^2(4) = 15.40$, $p < .01$. Post-hoc tests revealed no significant effects for either the international only or national only publications. For the national/international publications there were fewer agency only and agency/research publications than expected.

Note that 7% of agency/research organization collaborations in the Black Saturday Bushfires data set, 19% of those in the Canterbury Earthquake Sequence data set,

and 68% of those in the Haiti Earthquake data set are affiliated only with international organizations. The numbers of international agency affiliations are small, even in the Haiti data set. While the proportions of agency involvement are consistent overall (at 18-23%), they vary in terms of international affiliation.

Only the Haiti Earthquake data set featured significant international involvement in the agency-only affiliated category (Figure 10). In the other three data sets agency-only affiliated items were almost all national. International agency affiliation in items affiliated to both agencies and research organizations was higher in the earthquake disaster data sets.

2.3.2 Disciplinary integration

Proportional distribution of STEM disciplinary categories varied across the data sets, but STEM/non-STEM collaboration was consistently minimal (Figure 11).

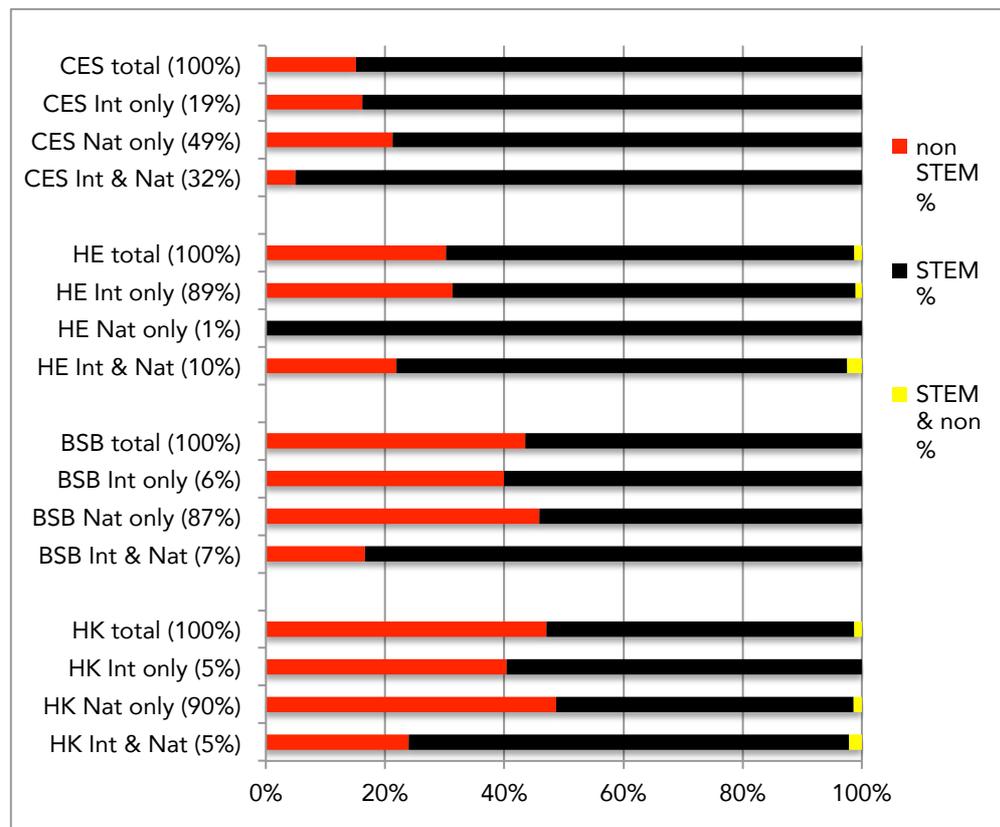


Figure 11: Comparative proportions of STEM & non-STEM categories overall, and by international and national affiliation.

The Hurricane Katrina data set featured the lowest proportion of STEM items overall, at 52%. Levels of STEM items were higher in the earthquake data sets. 69% of Haiti Earthquake items fell into this category, with CES items featuring the highest proportion of STEM items overall at 85% (Figure 11). STEM disciplines also appeared to predominate in national and international collaborations, and – to a lesser extent – in international publications (note that numbers of internationally authored publications in the Hurricane Katrina and Black Saturday Bushfires data sets are very low) (Figure 11). With the exception of the Haiti Earthquake data set, non-STEM levels were highest in items affiliated only to national organizations, and lowest in items affiliated to both international and national organizations. Almost all such collaborations in the CES data set fell into STEM disciplinary categories, as did 84% of the further 19% of CES items that had only international authors. 89% of items in the Haiti Earthquake data set were affiliated only with international organizations. Of these, 68% fell into STEM categories, as did 76% of the 10% of Haiti Earthquake items affiliated to both international and Haitian organizations.

A chi-squared analysis on the number of STEM and non-STEM (non-STEM plus mixed STEM-non STEM) as a function of disasters revealed a significant effect, $X^2(3) = 98.28, p < .0001$. Post-hoc tests ($p < .01$) revealed significant effects for each disaster except for Black Saturday Bushfires (for which the number of each type of publication did not differ from that expected). The number of STEM only publications was significantly lower than expected after the Haiti earthquake and after Hurricane Katrina. The proportion of STEM publication was significantly higher and the proportion of non-STEM significantly lower than expected after the CES.

A chi-squared analysis on the number of STEM and non-STEM (non-STEM plus mixed STEM-non STEM) as a function of source totaled across all data sets revealed a significant effect, $X^2(2) = 68.6, p < .0001$. Post-hoc tests ($p < .01$) revealed significant effects for each source of publications. The number of STEM only publications was significantly lower than expected in national only

publications but significantly higher than expected in the international only and mixed national/international publications.

For each of the four data sets a separate chi-squared analysis was conducted on the number of STEM and non-STEM articles by international only, national only and national/international affiliation. For the Haiti Earthquake and Black Saturday Bushfires data sets the chi-squared was not significant, the number of publications in each cell was as expected. For both CES and Hurricane Katrina there was a significant effect, $X^2(2) = 5.72$, $p < .05$ and $X^2(2) = 11.5$, $p < .001$. Post-hoc tests for CES and Hurricane Katrina revealed in both cases a significant effect only for combined national/international publications. For both disasters the number of STEM articles was significantly higher than expected and the number of non-STEM significantly lower than expected.

2.4 Discussion

The reported analysis looked at distributions of organizational affiliation type, the density of affiliation to organizations, national and international affiliations, and proportions of STEM and non-STEM disciplinary categories, to derive greater understanding of how the shape of the CES publication data set compared, in these areas, with those related to other contemporary disasters.

2.4.1 Agency affiliation

In the first instance, organizational affiliations indicated that proportional levels of research organizational and agency affiliation were broadly similar across all four data sets. Levels of agency involvement were higher than might be expected, given that these are peer reviewed research publications. The proportion of items in these data sets that featured affiliation with at least one agency ranged from sixteen to twenty-three percent, levels well above the (9%) level of agency affiliation recently identified in the broader disaster risk reduction research field (Gall et al. 2015). This suggests that the post-disaster environment may offer, and indeed stimulate, greater opportunities for agency involvement in research

activity. To the extent that agency involvement was consistently higher regardless of the location and type of the disaster suggests that this effect may be related to factors common to all post-disaster environments, such as time-compression and urgency.

This elevated level of agency involvement is consistent with the work of Birkland (1998) and Busenberg (2008, 2010, 2011), who find that the increased urgency created by the focusing effect of disasters can increase opportunities for building the research/policy networks required if research is to become the basis of effective disaster risk management policy. As Gall et al. (2015) argue, agencies involved in response and recovery to major disaster events are particularly in need of such networks.

The chi-squared analysis of data totaled across all four publication data sets showed more research only affiliations than expected for national only items, and fewer research only and more agency only affiliations for international/national publications. Pointing to collaboration with international organizations after disasters, these findings reflect the increased opportunities for integration in support of national response and recovery decision-making associated with international collaborations after disasters.

International agency affiliation complicated this picture however. Agency affiliation in the Hurricane Katrina and Black Saturday Bushfires data sets was almost entirely national, but this was not the case in the earthquake disaster data sets. The largest discrepancy was found in the Haiti Earthquake data set, where only six percent of items were affiliated to national agencies, although one agency, the Bureau des Mines et de l'Energie d'Haïti was affiliated to 2% of all items, the largest proportion of items linked to a single national organization in this data set.

Most discussion pertaining to the engagement of agencies and other stakeholders in research processes assumes that agency jurisdiction and research activity are based in the same location. This is evident in Gall et al.'s (2015) concern, for example, about the difficulties international researchers may face when it comes

to building networks with agencies and other stakeholders in the countries that are their research focus. These data sets suggest, however, that in itself agency affiliation did not necessarily index the engagement of agencies based within the researched, target country. Although indicative only, due to the small numbers of publications involved, international agency affiliations in these data sets serve as a useful reminder of the importance of including place when considering stakeholder engagement.

It is important to reiterate that the extent to which national agencies were actually involved in research collaborations after disasters could not be extrapolated from these affiliation levels. National agency affiliations to research publications represent only a small proportion of collaborative research activity involving agencies after these disasters, since not all national agency involvement results in affiliation to research publications. It is also important to acknowledge the related point in terms of international agency involvement. Many of the international agencies affiliated to publications featuring only international authors in the Haiti Earthquake data set, for example, were hospitals or branches of the armed services. Most of these publications concerned aspects of activities in support of Haitian agencies and communities, and to this extent pointed to organizational collaboration on the ground that was not reflected in affiliations.

2.4.2 International affiliation

Levels of international affiliation were broadly consistent across the Hurricane Katrina and Black Saturday Bushfire data sets, at below fifteen percent, even though these data sets marked either end of the size range (at nine-hundred and seventy-eight and eighty-five items respectively). International affiliation levels were higher in the Canterbury Earthquake Sequence and Haiti Earthquake data sets. Half of all Canterbury Earthquake Sequence publications featured international affiliation, and ninety-nine percent of items in the Haiti Earthquake data set were affiliated with at least one international organization. There are several possible factors that could be at play in these higher levels. Population size and proportional disaster impacts are a likely contributing factor, given the

consistent levels between the Australian and the US data sets. Small island nations, Haiti and New Zealand were proportionally more heavily impacted by these disasters, as indicated by losses as percentage of GDP and deaths as a percentage of these overall populations. Low population numbers and higher impacts were more likely to mean greater need of support from international research communities. The other commonality between these two events is disaster type. The international earthquake research community has been found to be highly networked and active internationally, which may also have been a factor in higher levels of international involvement in the Haiti Earthquake and CES data sets (Liu et al. 2012).

The variation between these two earthquake data sets indicates that the level of proportional impact on the country was a likely factor in both the extent of international affiliation, and levels of combined national and international affiliation. Mixed national and international affiliation occurred in thirty-two percent of items in the Canterbury Earthquake Sequence data set, but only ten percent of Haiti Earthquake data set items, with eighty-nine percent affiliated only to international organizations. Since the disaster type, earthquake magnitude, and proximity to a major city were broadly similar (Table 1), the catastrophic impact of the Haiti Earthquake is also a consequence of development status, as Crowley and Elliott (2012) suggest (see also World Bank 2010). Creating an acute need for international assistance of all kinds, the Haiti Earthquake disaster devastated national agencies, organizations and networks, as well as built infrastructure, severely aggravating already high levels of existing need (World Bank 2011). The level of disaster impact on Haitian agencies and research organizations is certain to have contributed to low levels of affiliation to Haitian organizations. Two further contributing factors are less directly linked to the disaster. French, rather than English, is spoken in Haiti. This increased the difficulties faced by Haitians wishing to publish in English, and also meant that Haitian research published in French fell outside the focus of these data sets on English language publications. The second factor is directly related to the drive for scientific credibility. Recent findings have confirmed complex quality assurance peer review systems are harder to negotiate for researchers from developing nations, who are less likely to have submitted

material accepted by peer review journals than those from developed nations; such researchers are also less likely to have access to research funding (Gall et al. 2015, Taskin 2010, Liu et al. 2012).

The chi squared analyses of organization type as a factor of international affiliation across all four data sets found that national/international affiliated publications had higher than expected levels of agency/research affiliation. When analysed individually, the two smaller data sets revealed no significant effects. The chi squared analysis of the Haiti Earthquake data set was consistent with the broader analysis, in that publications affiliated both nationally and internationally there were higher than expected numbers of research/agency affiliation. This was reversed in the Hurricane Katrina data set, where national/international publications featured lower than expected numbers of research/agency affiliation than expected.

It is likely that the variation between individual data sets reflects the real differences between post-disaster publication fields. The contrasting findings concerning the two larger data sets, for example, can be related to the inverse proportionality of international and national affiliation. This, again, can be related to the respective positioning of Haiti and the US at either end of both proportional disaster impact and development spectra. The US produces the majority of research in the hazard and disaster risk management field (Gall et al. 2015, NAS 2006). It follows that agencies would be more likely to engage national expertise after a disaster, which would limit agency engagement with international organizations. Conversely, since the majority of the comparatively small proportion of national organization involvement in the Haiti Earthquake data set occurred through collaboration with international organizations, it is likely that international/national collaborations would also feature higher than expected levels of agency/research collaborations.

The same factors are likely to have influenced the ratio of 1.5 organizations to 1 document in the Haiti Earthquake data set, which indicates a larger number of international organizations were involved in research activity in this devastated

post-disaster zone for every one item published. Again, the Hurricane Katrina data set appears at the other end of this spectrum; with the highest proportion of national-only affiliations (90%) and the lowest ratio of organizations to documents (0.7 organization per 1 item), this data set suggests that the publication field it represents was based on research activity involving the smallest number of organizations per item, and that this activity was focused through predominantly national organizations.

2.4.3 Disciplinarity: STEM/non-STEM distribution

The larger hazard and disaster risk management domain has been traditionally dominated by STEM disciplines (NSC 2006). All these data sets featured overall STEM levels above fifty percent, but varied above this level, and also in relation to national and international affiliation. The NSC (2006) synthesis study of social science engagement in disaster related research fields noted that on the basis of membership in professional bodies, it was possible the ratio of specialist disaster-related scientists to the physical sciences and engineering may be as disparate as 1 to 20. Recent bibliometric findings concerning the disaster risk reduction publication field (rather than self-identified disaster specialisation) over the last decade suggested a more even ratio, although specialist earthquake publication fields remain dominated by physical science and engineering disciplines (Gall et al. 2015, Liu et al. 2012).

The disparity between levels of STEM items across these disaster sets, however, does not point to disaster type as an overwhelming determinant of STEM to non-STEM ratios. The chi-squared analyses indicated that the STEM to non-STEM ratio was as expected only in the Black Saturday Bushfires data set. Both the Haiti Earthquake and Hurricane Katrina data sets featured significantly lower than expected numbers of STEM items, in contrast to the Canterbury Earthquake Sequence data set, which featured a higher than expected number of STEM items. The number of STEM only items was significantly higher in the Canterbury Earthquake Sequence data set, which also featured a significantly lower level of non-STEM than expected. National/international affiliation items in both the

Canterbury Earthquake Sequence and Hurricane Katrina data sets had a larger number of STEM and smaller number of non-STEM levels than expected.

The disparity across these data sets indicates that numbers of STEM items in the Canterbury Earthquake Sequence data set are high, suggesting that there are other factors at play in the distribution of STEM items,

2.4.4 Capacity building opportunities

Other recent findings have indicated that global disaster risk reduction and earthquake research fields are dominated by increasingly dense networks of researchers from developed countries, the US and Europe (Gall et al. 2015, Liu et al 2012). The link between levels of international involvement in these data sets and proportional disaster impacts is broadly consistent with the idea that the post-disaster environment can have a magnifying effect on opportunities for national engagement in these global research networks, and so for building national capacity.

Equally, however, post-disaster environments have been found to have a magnifying effect on existing inequities, largely due to time-compression (Olshansky et al. 2012). It is likely that the Haiti Earthquake disaster magnified difficulties already faced by locals when it came to publishing, and so increased the marginalization of already disadvantaged researchers and research organizations in this part of the world. Low rates of national affiliation, the large volume of research publications, and the high proportion of international affiliation in those publications, thus also point to the risks posed by the convergence of international researchers into post-disaster environments identified by the IAVCEI and the Working Group for Disaster Research Ethics (Newhall et al. 1999, Sumathipala et al. 2010). These risks are an effect of the intensification of domain drivers, as part of what Birkland (1998) has called the focusing effect of high profile disasters. Individuals and organisations are motivated on the one hand by the urgent need for support created by disaster impacts and the need to learn relevant lessons, and on the other by the importance of ensuring that post-

disaster research is scientifically credible. Neither individuals nor organisations are in a position to manage or monitor the larger pressure they collectively assert.

This pressure again draws attention to the larger set of questions that pertain to the relative distribution of disaster research burdens and benefits, as in the Belmont Code's distributive justice principle. These considerations are likely to become increasingly urgent, due to the much greater human cost and infrastructure damage caused by disasters in rapidly developing, increasingly urban nations, and recent predictions that if this trend continues, such highly destructive events are likely to become both more frequent, and more devastating, in the short to medium term (Crowley and Elliott 2012).

Evaluating the extent to which research can and does provide benefits in this context can be complex and difficult, and this difficulty is aggravated by the time-compression and urgency characterizing the post-disaster environment (Sumathipala et al. 2010). It has been suggested, in view of this, that the principle of distributive justice can be most usefully interpreted as a capacity building requirement (Sumathipala et al. 2010). A small early example of this approach followed the Oklamoma Bombing, when the Disaster Research Study Group were empowered to require that all out of state researchers worked with a local research collaborator (Quick 1998, North 2002). The appeal of this idea is that it offers to turn a source of risk into a research opportunity for individuals and organizations after disasters, and work against the exclusionary effect the scientific drive for credibility is currently having on researchers and research organizations in developing nations.

The most obvious and immediate indicator of such capacity building is authorship, and associated affiliations (Sumathipala et al. 2010). Of immediate benefit to researchers and research organizations, co-author affiliations in a peer-reviewed post-disaster research publication provide an indication of which individuals and organizations have shared that benefit. Requiring engagement in research and writing processes, authorship and organizational affiliations also give some indication of the extent to which the research in question has involved capacity

building in organizations and communities in the researched country, as well as that of the international researcher.

2.4.5 The Canterbury Earthquake Sequence publication field

These comparative findings are suggestive, as an indication of the Canterbury Earthquake Sequence publication field in context. They indicate that the post-disaster environment may have had a generally stimulating effect on agency involvement in research publications. It is also likely that some features in the shape of this publication field are related to the high proportional impacts the CES had on New Zealand, due to the severity of the event in relation to this nation's small size and low population level. These features include high levels of international involvement, and of national/international research collaborations.

Another contributing factor here may be New Zealand's tradition of advanced earthquake research (Liu et al. 2012; Crowley & Elliott 2012). Particularly strong in the engineering and physical sciences, this tradition has included extensive international collaboration and networking in the decades leading up to the Canterbury Earthquake Sequence (Center for Advanced Engineering 1997). This tradition may also be a factor in the higher than expected ratio of STEM to non-STEM research items in the Canterbury Earthquake Sequence data-set.

Finally, although all three fields concerned with disasters in developed countries featured higher levels of affiliation density to three national research organizations, these levels were highest in the Canterbury Earthquake Sequence publication field. All three are NHRP member organisations. It is not possible to draw conclusions on the basis of this data alone. It is possible, however, to note that the high levels of affiliation to these three organisations are not inconsistent with the NHRP's role coordinating research in support of Canterbury Earthquake Sequence response and recovery operations.

2.5 Conclusions

Overall, these data sets indicated a consistently higher level of agency involvement in research publications than that of the wider disaster risk reduction publication field. This is consistent with the idea that such environments may offer increased opportunities for science/policy integration, and since these levels were similar across the data set, indicated that such opportunities are likely to be related to factors common to all post-disaster environments.

The findings also indicated that proportional impact was a likely factor in the levels of international involvement in post-disaster research activity. These levels appeared higher in the countries with the higher proportional impacts, and highest in the Haiti Earthquake, where impacts were catastrophic. Since both small size and development status play a part in proportional disaster impacts (UNISDR 2015), these findings suggest that international research pressure is an additional risk such countries are likely to face after disasters.

3.1 Introduction

The United Nations International Strategy for Disaster Reduction (UNISDR) defines disaster as the 'serious disruption of the functioning of a community or society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources' (p.9 UNISDR 2009). The levels of uncertainty and unknowns created by this level of disruption make major natural disasters literally definitive of chaotic decision-making environments (Van de Walle & Turoff 2008, Schloss 2014). It follows that the immediate response to such events requires a degree of top down management to provide 'emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected' (p. 24 UNISDR 2009). Research conducted in disaster impacted regions has not been routinely included in the activities managed as part of emergency response operations, although there are a few precedents for restricting research access during such operations (Quick 1998, North et al. 2002, van Zijll de Jong et al. 2011).

There is increasing evidence, however, that high profile disasters can generate surges in research activity, creating a range of scientific opportunities and risks. Birkland (1998) has established that the politicizing effect of US earthquake disasters has triggered increases in research funding and activity, greater likelihood of effective policy/science collaborations, and greater uptake of science by policymakers. Equally, however, the focusing effect of disasters has also been found to escalate research activity at the expense of scientific quality, when large volumes of often duplicative research are produced for largely opportunistic or political ends (Rodriguez et al. 2007, Black 2003, Birkland 2009). The convergence

of researchers into a disaster zone, moreover, has been identified as a significant additional burden on regions struggling to cope in the aftermath of disaster (Brown & Donini 2014, Walton-Ellery & Rashid 2012, Sumathipala et al. 2010, Brun 2009, Gill et al. 2007, Sumathipala & Siribaddana 2005). The Belmont Report (1979) provided three principles – informed consent, beneficence, and distributive justice – that continue to mark ethical limits beyond which researchers are not free to collect scientific data. Finding that increased research activity in disaster zones risks breaching both the beneficence and distributive justice principles, several ethicists have called for more active interventions to manage such activity, with a view to reducing this risk after disasters (Sumathipala & Siribaddana 2005, Citraningtyas et al. 2010, Sumathipala et al. 2010).

In this chapter, research engagement after the 22nd February 2011 M_w 6.2 Christchurch earthquake is used to explore the use of the NHRP to support the science/policy interface for response and recovery decision-making, and manage the mix of scientific opportunity and risk generated by this disaster event. Two weeks after the Christchurch Earthquake a national directive required that social scientists refrain from contacting impacted populations during the two-month state of national emergency. Indexing the issue of escalating pressure from international researchers after disasters, this directive also raises the question of managing such pressure in accordance with the principles provided by the Belmont Report (1979).

3.1.1 Materials

The chapter is largely based on secondary data. This includes a range of NHRP and other government documentation in the public domain, including the Ministry of Civil Defence and Emergency Management (MCDEM) review of the emergency response and the Royal Commission of Enquiry into the Canterbury Earthquakes Report (Mclean et al. 2012). It draws on material from the National Crisis Management Center (NCMC) Log during the state of national emergency (22nd February – 30th April 2011), and the Ministry of Business, Innovation and Economics (MBIE) review of the NHRP (Buwalda et al. 2014), as well as scientific

and grey literature concerning the Canterbury earthquake sequence and its impacts, as available⁸. The chapter is also informed by observational and other data collected by the candidate and members of her supervisory team. All were involved in aspects of the larger response operation to this event, with some representing the NHRP on the science desk in the Christchurch Response Center during the state of national emergency. Secondary data concerning the directive restricting research access to impacted populations included a number of emails and other personal communications. Due to sensitivities around this issue, these were not referenced individually, in order to protect the anonymity of those concerned. Note also that since this directive was not officially formulated, and so has no official title, it was termed the moratorium directive, for ease of reference, and reflecting common usage at the time.

3.2 Context

In recent decades increasingly complex and fragmented policy-making environment has driven growing reliance on non-state scientific, financial and other expertise for resources and cooperation, and an associated emphasis on the use of evidence as the basis of policy (Gluckman 2013, Skogstad 2003). Over the same period, calls for inter-disciplinary approaches which integrate end-users in all stages of the research process have become widespread in a range of domains (McNie 2007). A concomitant body of research has focused on integrative research/end-user initiatives, establishing that inevitable tensions between researchers and policy makers need to be negotiated, especially around the concepts of scientific credibility and political relevance (Cash & Moser 2000). In addition, such initiatives have been found to be equally reliant on the perception that knowledge-generating processes have been legitimate, or fair and balanced, in the treatment of diverging and conflicting stakeholder views and interests (Clark & Majone 1985, Cash et al. 2003). This balance can be difficult to maintain, as

⁸ The 1999 Fourth International Conference on Grey Literature in Washington, DC defines grey literature as: "That which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers." (www.greylit.org; accessed 1 August 2014)

cross-sector collaborations can create new issues that require on-going decision-making about geographical, functional, structural and participatory parameters (Verweij et al. 2014). Decisions about these boundaries point back to the underlying judgments and expectations on which they are based, and can also create further issues as the relevant collaboration develops (Verweij et al. 2014).

As yet, however, these ideas have not been widely applied in the hazard and disaster field, which also features limited research focused directly on the collaborative management of research activity after disasters. This lack of research focus is despite a longstanding recognition of the need for more integrated approaches to research and policy in the disaster risk management area. A key tenet in official United Nations disaster risk reduction policy for the last decade (ICSU 2008, UNISDR 2005, 2011), the drive to create an integrated DRR environment is the central plank of the 2015 Sendai Framework (UNISDR 2015).

3.2.1 New Zealand natural hazard and security management

Informing most government approaches to hazard and disaster research funding (UNISDR 2005, Few & Barclay 2011), the drive for a more integrated national approach to researching and managing hazard and disaster risk in New Zealand has informed a series of legislative changes in New Zealand. The Resource Management Act (1991), the Crown Research Institutes (CRI) Act 1992 and the Earthquake Commission (EQC) Act 1993 all regulated the provision of hazards research in the national interest. In 2002 the Civil Defence and Emergency Management (CDEM) Act built on these and other legislative changes to shift national hazard management “from centralized, rules-based, response organizations towards more flexible arrangements based on principles, culture, mitigation and local knowledge” (p. 70, Helm 2009). Devolving responsibility for risk to local and regional levels, with the goal of building networks at, and between, those levels, this policy was explicitly focused on increasing the overall resilience of the larger complex system that includes both hazards and society (CDEM Act 2002, Helm 1996, 2009, Smith 2009).

3.2.2 The Natural Hazards Research Platform

In 2007 the New Zealand research-funding environment was identified as the most highly competitive in the OECD (Smith 2009). Concern about the effects of this environment gave new force to initiatives aiming to develop hazard and disaster research clusters in the response structure (MCDEM 2009, Smith 2009), and informed the development of the Natural Hazards Research Platform (NHRP) (NHRP 2009A). Launched in 2009, the NHRP was a pilot platform, set up to trial the national research platform concept (NHRP 2009A). It was to work towards “a New Zealand society that is more resilient to natural hazards,” and so further the Crown vision already articulated in MCDEM legislation (p.5, NHRP 2009B). Designed to manage competitive behavior by providing a framework to integrate medium to long-term research and funding in areas of national interest, such platforms were expected to catalyse new, more collaborative networks between organizations, disciplines and agencies already involved in the relevant domain.

The NHRP brought together research organizations with existing hazard and disaster research capacity, but distinct existing priorities. The National Institute of Weather and Atmospheric Research (NIWA) and the NHRP host organization, Geological and Nuclear Sciences (GNS Science), are Crown-owned companies required to conduct scientific research for the benefit of New Zealand (Sections 4 and 5.1(a), CRI Act 1992). What was new about the platform was that it brought these CRIs together not only with Opus, a private research consultancy, but also with three of New Zealand’s eight universities, the Universities of Canterbury and Auckland and Massey University. In addition to integrating research activities across these different organizations, the NHRP was required to integrate relevant disciplines into five broad thematic areas. Two of these, risk management and social resilience, were to cut across and so integrate the three themes more traditionally associated with hazard and disaster management: geological hazards models, weather and flood prediction and resilient buildings and infrastructure (NHRP 2009A).

The NHRP was guided by principles that prioritised research issues raised in particular government agency strategies, the endorsement of research programs by end-users, including government agencies, and (where possible) the involvement of such end-users in all stages of the research design process (NHRP 2009A). Other principles referred to national and international networking and coordination, the prioritization of integration across organizational, disciplinary and sector boundaries, and research of high quality (NHRP 2009A). The emphasis was to be on long-term research projects, and – through them – the development of an enduring and extensive network that would bring diverse research organizations and agencies together.

As well, however, the NHRP was to be responsive to changing government priorities and evolving science needs. This principle included responsibility for assisting the nation to respond to significant hazard events, and for capitalizing on the learning opportunities such events create (NHRP 2009A). Responsibility for assisting the response had been subsumed in the existing responsibility of the host organization, GNS Science, to provide hazard and disaster advice to the Crown (GNS Science 2011). The NHRP strategy document specified this role explicitly, meaning that coordination of research activity during and after the 2010-2011 Canterbury Earthquake Sequence fell within the remit of the NHRP.

3.2.3 The Canterbury earthquake sequence

On 4 September 2010 the M_w 7.1 Darfield earthquake occurred 10 km deep and ~35km west of Christchurch, New Zealand's second largest city (pop. 390,300⁹). This was the first event in a sixteen-month sequence of earthquakes that trended eastwards across Christchurch, punctuated by a further three large events which caused significant additional damage (Bradley et al. 2014) . The second, and most damaging of these larger events occurred on 22 February 2011, when the M_w 6.2

⁹ Estimated as at June 2010. Source: Subnational Population Estimates: At 30 June 2010. Statistics New Zealand. <http://www.stats.govt.nz/>.

Christchurch Earthquake led to 185 deaths and more than 6,500 injuries (Johnston et al. 2014). The Darfield earthquake had been coordinated at the regional level. The scale of the disaster caused by the Christchurch Earthquake, and the magnitude of the required response and recovery operations led to the declaration of the first state of national emergency in New Zealand, on the 23rd February 2011, which lasted until the activation of the Canterbury Earthquake Recovery Authority (CERA) on the 1st May 2011. A purpose-built central government agency of limited duration, CERA was tasked with managing the overall recovery strategy, and given a range of powers designed to reduce obstacles to recovery decision-making (Johnson & Mamula-Seadon 2014). This chapter uses Canterbury earthquake sequence when referring to the larger, cumulative earthquake disaster. It is largely focused, however, on the state of national emergency period that followed the Christchurch Earthquake.

3.3 The Canterbury earthquake sequence: science coordination

The Canterbury earthquake sequence created a range of new science requirements and opportunities. Although mandated to coordinate research in response to both, the NHRP was newly formed and lacked detailed protocols for response coordination (NHRP 2009B). As a result the development of the NHRP coordination effort over this period was largely organic, responding to developments in the wider environment. After the initial Darfield Earthquake local Christchurch scientists self-activated within hours, conducting assessments and gathering fault, seismic, liquefaction, building and infrastructure data across the city and surrounds. In support of the response, much of this activity was also for more basic research purposes (Quigley et al. 2012). Within days, it had developed into the series of broadly themed research operations that was to characterize the ongoing collaborative research effort coordinated by the NHRP during the Canterbury Earthquake Sequence. (Table 5: Appendix 2).

The response operation to the Darfield earthquake was coordinated at the regional level by the CDEM Group based in Environment Canterbury, the Canterbury Regional Authority (Johnson & Mamula-Seadon 2014). For this reason,

the wider research effort was loosely coordinated through daily NHRP briefing sessions also held at Environment Canterbury. Attended by representatives from the NHRP, member organizations, key research operations, response agencies and others, this forum provided updates concerning the previous day's research and ongoing research priorities and issues; representatives were then able to brief others. Raising awareness across the wider research effort, these daily sessions provided a crucial channel of two-way communication, both within the post-disaster research collaboration and with responding agencies.

The much greater devastation caused by the M_w 6.2 Christchurch earthquake on 22 February 2011 prompted New Zealand's first ever declaration of a state of national emergency, and – in a major deviation from existing MCDEM procedure – the co-location of district, regional and national response levels of operation on site, run by the National Controller from a single Christchurch Response Center. Also for the first time, this operations center explicitly included a Science Liaison function (McLean et al. 2012). This function was managed by the NHRP, which also staffed the Science Desk centrally positioned in the new Christchurch Response Center. Reflecting both the gains made after the Darfield earthquake, and the politicizing effect of this second, more destructive event, this explicit acknowledgement of the role of science in the response helped the NHRP cement the gains in end-user engagement made after the earlier event.

As the organic development of the NHRP's coordination role adapted to incorporate the new science liaison function, new challenges emerged. McLean et al. (2012) found that confusion arising out of the new structure, regional political tensions within the response operation, and a lack of appropriate information technology made communication difficult within the Christchurch Response Center. This meant many relied on face-to-face communication, which in turn required physically finding others located in the Christchurch Response Center (McLean et al. 2012). The NHRP's ability to negotiate these issues was improved by its new location at the Science Desk, and by the NHRP manager's participation at daily high-level Response Center briefings. These gains were somewhat offset, however, by the speed with which the new science function was introduced, which

meant there was no time to officially incorporate it into the modular CIMS structure, or add a science section to the Situation Report format informed by this structure (NCMC Log). The introduction of such a section would have improved the NHRP's ability to communicate with the agencies involved in the response operation, since this was another significant channel of communication within the wider response operation (NCMC Log, McLean et al. 2012).

A science section in the Situation Report would also have helped improve communication across the wider research operation coordinated by the NHRP. Although the engineering response operation held its own briefing sessions, as did some of the geotechnical research programs, the NHRP did not conduct daily research briefing sessions, as it had done after the Darfield Earthquake. This was largely due to the much greater scale and complexity of this second science effort. The loss of the wider daily science briefing session, however, removed the forum that, during the Darfield response, had fed into functional and structural NHRP decision-making, and informed response agencies, as well as raising awareness across disparate research programs. These communication issues were compounded by a structural issue, which arose out of the crossover between the new NHRP coordinating role, and the more familiar advisory and support responsibilities of its host organization GNS Science (Buwalda et al. 2014). Assumptions as to the demarcation of tasks and responsibilities between the Crown Research Institute and the larger consortium tended to default to GNS Science. Although the NHRP was officially responsible for science coordination, those representing this consortium were routinely understood by most agencies to be working for GNS Science, for example. Similarly, the Science Liaison desk was often described as the GNS desk. Later, this would be continued in an ongoing lack of reference to the NHRP in most official review documents, which like the NCMC Log, referred only to GNS Science in relation to science coordination in the CRC (e.g. Cooper et al. 2012, Mclean et al. 2012, OAG 2012). This meant that the NHRP's coordinating role remained largely behind the scenes.

3.3.1 Research Participation Decisions After The Christchurch Earthquake

A significant aspect of this role involved allocation of existing and additional research funding to earthquake-related projects. Allocation decisions made by the NHRP management group enabled a range of research activities that were not being directly coordinated by the NHRP, including engineering and geotechnical programs, and so extended the reach of its coordinating influence. The government provided an additional NZ\$1 million in research funding after the Darfield earthquake, and a further NZ\$3 million after the Christchurch earthquake (Berryman 2012). Some of this was allocated retrospectively as reimbursement for projects initiated immediately after these events, particularly those in support of the response operation, as well as for major new research programs. Calls for proposals (including retrospective applications) made funding conditional, however, on a letter, or letters, proving endorsement of the relevant research project by an agency or organization involved in the response and recovery operations in Christchurch. This requirement clarified a fundamental NHRP expectation: that research into these events should integrate the needs of end-users, and so increase the uptake of research in policy decisions. In addition, it forced researchers to engage with agencies and organizations involved in the response, and so to this extent brought current and potential research activity to their attention, further opening the possibility of cross-sector collaboration.

Decisions involving participation can also clarify less explicit underlying assumptions (Verweij et al. 2014). This NHRP requirement for evidence of agency endorsement effectively excluded researchers disinclined or unable to engage with response agencies from these funding rounds. Existing hazard and disaster researchers and teams were most able to fulfill the requirement, since they were likely to have already developed links with agencies and other researchers in this field. To some extent this reflected the original NHRP focus on the maintenance of existing hazard and disaster research capacity. Although this capacity was represented, at that time, by member organizations, it is clear that the NHRP's coordinating role extended well beyond research activities involving these organizations. International research teams contributing to this collaborative effort

after both events included researchers from organizations such as Geotechnical Extreme Events Reconnaissance (GEER), the Earthquake Engineering Research Institute (EERI) and the Technical Council on Lifeline Earthquake Engineering (TCLEE), a branch of the American Society of Civil Engineers (ASCE). In addition, research funding decisions brought other local and national research providers into the larger coordinated science effort, including Lincoln, Victoria and Otago Universities, as well as a range of private geological and geotechnical science providers. This did not lead, however, to the expansion of NHRP membership in response to the new opportunities generated by the earthquakes (Buwalda et al. 2014).

The second implicit assumption that constrained the NHRP's coordinating role concerned scope. Most of those involved understood that the scope of this role did not extend beyond the larger research effort funded and/or coordinated by the consortium. This assumption was shared well beyond those directly or indirectly involved with the NHRP. It was likely to have been informed on the one hand by widespread respect for research autonomy, and on the other, by the urgent, larger focus on response-related activities.

In addition to the large, loosely networked research collaboration with agencies coordinated by the NHRP, however, the Canterbury earthquake sequence also attracted the attention of local and national researchers with little or no prior engagement in the field, and of international researchers excited by the research opportunities offered by these events. The pronounced geotechnical impacts of these earthquakes in a city where development had been required to meet high-seismic building codes made these opportunities particularly attractive to hazard and disaster researchers. That this disaster zone was in a developed, English speaking nation with a well-networked research community may also have increased its appeal as a research destination. By the time the Christchurch Earthquake occurred, international research interest generated in the wake of the Darfield event was already well in excess of the hosting, collaborative capacity of New Zealand researchers who were engaged with the response.

The high profile generated by the more destructive Christchurch Earthquake appeared to immediately escalate this research interest. Senior local researchers were contacted within a day of this event by a number of international research teams seeking to arrange new data gathering visits within weeks. Consulted at that point, NHRP management confirmed that all science conducted in the region came under the aegis of the state of national emergency, and that for this reason the issue of research pressure on impacted communities was being discussed with the National Controller. Over the following week several senior CDEM personnel independently asked the National Controller to clarify the issue of international researcher visits, after persistent requests for research access from international researchers reluctant to accept advice, from these staff, to wait until the response period was over (NCCMC Log). The National Controller consulted with other CDEM personnel, the international desk in the Christchurch Response Center, and the NHRP. During the same period, increasing numbers of uninvited international researchers were arriving daily at the Christchurch Response Center. Requesting support from response agencies to access the closed off central business district, most were interested in liquefaction and building structural performance data. The volume of these visitors caused problems not just for staff in the Christchurch Response Center, but also for the large numbers of engineers and others already engaged in research projects in collaboration with the response, which were also based in the Christchurch Response Center (Social Science Situation Report 2011, McLean et al. 2012). By Monday 7 March, almost two weeks after the Christchurch earthquake, visiting researcher numbers had reached one hundred per day, forcing the introduction of a new Christchurch Response Center access protocol designed to restrict their entry (Engineering Situation Report 2011). It should be noted that these numbers refer only to those researchers who made contact with the Christchurch Response Center; overall visiting researcher numbers are likely to have been much higher.

3.3.2 Research Participation and the (Social Science) Moratorium Directive

On the same day, the National Controller's consultation over this issue culminated in a directive, issued under the state of emergency, requiring that all international

researchers should postpone data-gathering visits to the city until the state of national emergency was lifted, or until 1 May, whichever came earlier (NCMC Log). Social scientists, in particular, were to be held off until 1 of May. MCDEM did not have the resources required to host visiting researchers while engaged in the response, and the wider consensus opinion was that local communities should be given space before being interviewed by researchers. Geoscience and engineering fact-finding missions that did not include a community focus were to be the exception, as long as they were coordinated through NHRP, and so contributed to the science response (NCMC Log).

This directive was necessary, in order to address the escalation of research interest in the days after the earthquake. It was made by the National Controller, using the powers available to him under the state of national emergency, and informed by networking and advice from within the New Zealand hazard and disaster research community, NHRP management, and within MCDEM. The directive was not, however, officially formulated, widely promulgated, or accessible on any official websites. It was communicated by the National Controller's office to emergency management and other response personnel through the Coordinated Incident Management Structure (CIMS) structure. It did not feature prominently in the situation reports, which were an important communication mechanism within the wider response operation. This meant that although it was discussed with the international desk in the Christchurch Response Center (NCMC Log), it was not as widely disseminated as it could have been within the wider response operation.

The decision was also communicated informally to NHRP management. Those staffing the science desk were responsible for explaining the directive to visiting researchers arriving at the Christchurch Response Center. With the benefit of hindsight, it is likely that the difficulties of this task would have been reduced if it had been possible to refer visiting researchers to an officially worded and authorised version of the directive, on a relevant government website. NHRP researchers were also required to disseminate this directive through local and international hazard and disaster networks. There was no obvious mechanism for communicating the moratorium decision to local and international hazard and

disaster scientific communities, however, and even less possibility of reaching the rapidly burgeoning local research community inspired by the earthquake to enter the hazard and disaster field for the first time. The moratorium decision was made early after the Christchurch earthquake, a day or so before contact and collaboration was established between the NHRP and the office of the Chief Science Adviser, with a view to demarcating science communication tasks (NCCM log). Since a large part of this role is science communication with the public (Gluckman 2014), the Chief Science Adviser might have been well placed to help publicize both the moratorium directive, and the rationale behind it.

Later in March, local education organizations concerned about international research pressure contacted the University of Canterbury, and were informed about the moratorium directive by university management. Information about the moratorium was subsequently made available to pre-school, primary and secondary schools through the Ministry of Education. The NHRP collaborated with this Ministry to provide ethical guidelines for research conducted with education organizations after the moratorium was lifted, which included requiring all such research to have applied for and received ethics approval, and that all projects be registered with the Ministry.

Under the state of national emergency, the National Controller was authorized to exercise powers of compulsion. The moratorium directive was voluntary, however, as far as members of the science community were concerned. As a directive, its primary force was in requiring responding agencies and researchers involved in the collaboration with the response to decline requests for access and assistance from visiting researchers who were not contributing to that collaboration. International media crews wishing to document the activities of international researchers were also declined access (Social Science Situation Report 2011). Note that although the directive applied to research activity in the Greater Christchurch region after the earthquake, it was only possible to deny access to the cordoned off CBD. While all visiting researchers attempting to engage with this local collaboration were asked to respect the directive, there was no way to ensure that they did so. There was also no way to communicate the directive to visiting

researchers that did not attempt to contact local research and response operations, or indeed, to assess numbers of visiting researchers overall. As a proportion of overall research activity in the city at the time, those that did make contact indicated that these numbers were very high.

Those made aware of the moratorium were largely supportive, although some researchers were reluctant to accept the authority of the National Controller in this domain, or the rationale for his decision, or both.

3.4 Analysis

The NHRP's ability to coordinate the larger research effort in collaboration with the response was constrained by several factors. The initial parameters evidenced in the contract and strategy documents created a focus on existing capacity, and failed to distinguish clearly between the roles of the larger consortium and its member organizations during emergency responses. The NHRP had not had time to develop when the Canterbury earthquake sequence began. It was trialing a new consortium approach to research funding and coordination, and so had no precedent to follow. Despite these constraints, the NHRP played a significant role in the production of a coordinated range of scientific outputs of high quality (Buwalda et al. 2014), many of which fed directly into policy and practice decisions (Table 5: Appendix 2). The inclusion of a new science liaison function in the Christchurch Response Center, like the provision for the NHRP to coordinate emergency research support in future events in the new, draft CDEM plan (MCDEM 2014) testified to the new levels of collaboration with agencies achieved during and after these earthquakes. As a pilot consortium, despite significant constraints, the NHRP demonstrated that it is possible to bring a large section of the hazard and disaster research community into collaboration with the response operation. It also established that such consortiums have the potential to coordinate research activity after major disaster events in such a way as to increase the uptake of research opportunities, including the opportunity to engage end-users, and the provision of scientific evidence as the basis of decision-making, while also decreasing the risks to science quality documented after other

disasters.

On-going decision-making about the structural, functional, geographic and participatory boundaries of collaborations of this kind have been found to create new issues as the collaboration unfolds (Verweij et al. 2014). Looking more closely at such decisions concerning the larger collaboration between the response operation and the NHRP helps to clarify some of the issues arising out of the management of research activity after disasters. Many of these issues are best illustrated by the moratorium directive, which can be seen as a flash point. Driven by rapid developments after the disaster, this directive was the result of assumptions and swift decision-making concerning the distribution of tasks between the response operation and NHRP, the scope of NHRP function and responsibility, and participation in research activity into the disaster and its impacts. The directive is also important because it indexes the research pressure that Birkland and others have identified as a secondary effect of the high profile generated by major disasters (Birkland 2009, Rodriguez et al. 2007, Citraningtyas et al. 2010, Sumathipala et al. 2010, Newhall et al. 1999, Brown & Donini 2014, Gill et al. 2007). In addition to (scientific) risks to research quality, this pressure carries more immediate risks of particular concern to the response operation. As in the Christchurch Response Center, the volume of arriving researchers can compromise the ability of such operations – already overwhelmed by the disaster – to provide basic services to the impacted population (McLean et al. 2012). As well, the convergence of researchers into a disaster zone collectively risks creating a cumulative research burden on already stressed, impacted communities disproportionate to any benefits they may gain, in contravention of the Belmont Report's (1979) distributive justice principle (Brown & Donini 2014, Sumathipala et al. 2010, Citraningtyas et al. 2010). These immediate risks meant that the rapid escalation of research pressure after the Christchurch earthquake required active management, and rapid decision-making. Since increased research interest and pressure is a consequence of major disasters, this kind of increase in research activity will always require some form of active management if these risks are to be addressed (Newhall et al. 1999, Sumathipala et al. 2010, Brown & Donini 2014, Walton-Ellery & Rashid 2012, Gill et al, 2007).

3.4.1 The moratorium directive, visiting researchers and social scientists

As a necessary intervention designed to reduce these risks after the Christchurch Earthquake, however, the moratorium directive introduced a new research participation restriction that affected research activity in the impacted region. This restriction also marked a participation boundary in the larger collaboration between the response operation and activities coordinated by the NHRP. Participation boundary decisions of this kind carry the risk of creating the perception that the interests of a particular group have been ignored (Verweij et al. 2014). It has been well established that such perceptions risk bringing the legitimacy of the relevant collaborative activity into question, and so can put the larger collaborative enterprise at risk (Cash et al. 2003, McNie 2007, Parker & Crona 2012).

Possibly due to sensitivity around these and other issues, the moratorium directive was not officially formulated, or promulgated through the media. The speed with which this decision was forced by rapidly unfolding developments in the high-pressure post-disaster environment is also likely to be a factor here. As entered in the NCMC log, the National Controller's directive allowed only visiting researchers who joined programs coordinated by the NHRP to engage in research activity in the Greater Christchurch region, which was directly impacted by the disaster. This was in effect already the case. The vast majority of researchers arriving at the Christchurch Response Center were geotechnical and structural engineers, who were being declined access to red zones and support from the response and/or other researchers unless required by existing collaborative research projects. Overall, far more visiting engineers requested and were declined research access during this period than visiting social scientists. However because this log entry also specified holding off social scientists in particular, and because there was no official formulation to refer to, the directive was widely perceived and described as the social science moratorium. While the bluntness of this description was

effective in reducing immediate pressure on impacted populations, it was not strictly accurate. All visiting researchers not involved in local collaborations were subject to the directive, irrespective of discipline. And many agencies were conducting or engaging with social science initiatives that were gathering data to inform response decision-making; most, although not all, did not involve direct contact with impacted communities (such as statistical studies of existing data streams, literature searches and modeling of likely demographic effects, for example).

Restricting research contact with impacted populations during disaster response after disasters will always carry the risk of alienating the sectors of the research community that rely on such contact. In retrospect, however, phrasing this directive as a social science moratorium exacerbated this risk, by appearing to exclude an entire branch of science. To the extent that this indicated that the requirements of this section of the research community were not being considered, it also risked compromising the legitimacy of the larger collaboration. In hindsight, it is likely that these risks could have been reduced if this directive had been expressed as a collaboration requirement, in terms of its rationale (limiting the research burden on impacted populations) and effect (facilitating access to all researchers involved in the larger research effort being coordinated in collaboration with the response effort). This phrasing would still have required responders and researchers to refuse access to visiting researchers not required by this effort, but without appearing to single out social science. Phrasing the directive in terms of participation, rather than exclusion, would also have directed interested researchers to participation options, while clarifying the rationale would have been likely to have increased perceptions of the legitimacy of the coordinated research effort (Cash et al. 2003, McNie 2007, Parker & Crona 2012).

3.4.2 Structural boundary decisions (and the science/policy interface)

Senior researchers and CDEM staff had requested clear direction from the National Controller concerning visiting international researchers. Such a directive was only possible under the powers granted to this office under the state of

national emergency. Lending the authority of that office to a directive of this kind had other advantages. Making it easier for responders to decline access to visiting researchers, this authority also to some extent shielded local and national researchers from negative fall-out from sectors of the research community following the directive. A significant disadvantage, however, was that the directive was in effect a participation decision that directly affected the interests of the research community, and it appeared to have been made only by senior emergency managers (and so a government agency).

Effectively placing a moratorium on all research activity not part of this collaborative effort, this government directive risked alienating newly interested members of the local New Zealand research community, as well as sectors of national and international hazard and disaster research communities. Again, with the benefit of hindsight this risk might have been better managed with a joint directive, issued officially by the National Controller and the NHRP, making research activity conditional on collaboration with the response and specifying minimal contact with impacted populations. Direct responsibility for this directive, even when shared with this much more powerful entity, may have increased the exposure of the NHRP and member organizations to fall-out from research communities. But as a large research consortium, including several major national universities and Crown Research Institutes, the NHRP had the potential to spread this risk across institutions, and in this way reduce it. The official involvement of the NHRP as an equal partner in the moratorium decision would have clarified the breadth of support for the collaboration requirement across New Zealand research organizations. Ensuring that government agencies were not perceived to be making uninformed political decisions about research participation, this kind of joint directive would also have demonstrated that the research collaboration with the response coordinated by the NHRP reached to the highest levels. These potential benefits would have been greater, however, if the NHRP had been free to move rapidly to include new member organizations, and had also been more able to generate a much higher, more official profile over this period, both generally, and as distinct from GNS science in particular.

As a CDEM directive, the moratorium decision also clarified structural assumptions at the time concerning the distribution of responsibility for research activity in the disaster zone. Within hazard and disaster research networks, and across responding agencies, the NHRP was understood to be responsible for – and largely limited to – coordinating activities either actively driven and/or funded through this consortium. Research activity outside this larger collaboration thus fell under the aegis of the response, along with other activities in the disaster zone. Reflecting cultural expectations concerning research autonomy, these assumptions were also informed by the urgency and magnitude of the task facing the response, which tended to narrow the focus of all concerned onto the collaborative effort. They were in any case implicit in the consortium's initial parameters: the NHRP was set up to sustain and increase existing hazard and disaster networks, and so national capacity, not to actively manage the larger surge in research interest and activity that follows major disasters.

Newly interested local researchers, however, did not always share these assumptions. While private providers of psychosocial support to businesses and other organizations were in demand after the disaster, for example, those that attempted to ensure their activities were coordinated with and contributed to the larger response effort were unsuccessful (pers. com. J. Black, organizational psychologist). There were other instances in which local researchers, upon hearing of the NHRP, assumed this consortium was responsible for immediately acting to engage all local scientists interested in research after the disaster (many of these subsequently contributed to the research effort coordinated and funded by the NHRP). While opportunism is a factor in increased local research interest after disasters (Rodriguez et al. 2007, Birkland 2009), the desire to contribute research skills and time to the response and to the local community is at least as significant a motivating factor. As well as marking another instance of perceived exclusion, then, the initial disappointment created by mismatched assumptions about the scope of the NHRP's role underlines the peculiar relevance research into a disaster event carries for those researchers living in the impacted region. This issue arises out of the intersection of the boundaries defining the participatory and geographical extent of the coordinated post-disaster research effort. Although a

factor in NHRP research participation and funding decisions, it remained implicit, and did not appear in calls for research proposals, or other NHRP documents.

3.4.3 Transparency and communication (and the science/community interface)

Two broad themes can be seen running through the issues that arose out of decisions involving the geographical, functional, structural and participatory boundaries of the post-disaster research effort coordinated by the NHRP. Firstly, these issues all involved risks arising out of the perception that individuals or groups were being unfairly excluded by the relevant boundary decisions, which in turn posed risks to the legitimacy of the wider research effort. Secondly, these risks were all highlighted and exacerbated by communication and awareness issues. Difficulties formulating and promulgating the moratorium directive, for example, led to poor dissemination and impact with possible alienation of some research groups. Since the consultation process informing this and other decision-making remained behind the scenes, like the wider networks that informed NHRP activity, the directive was open to being misinterpreted as a government intervention that curtailed academic freedoms, while NHRP activity risked being misconstrued as that of a single member agency. And finally, misunderstandings about the scope of the NHRP's coordinating role contributed to feelings of disappointment and unfair exclusion in sectors of the wider research community living in the disaster zone

It follows that if communication issues and lack of awareness exacerbated these issues, improvements in these areas are likely to mitigate them. It has been established in the wider literature concerning complex cross-sector collaborations in high pressure environments that both communication and transparency contribute to perceptions of legitimate process, even among groups who have been excluded (Cash et al. 2003, McNie 2007, Cummings & Kiesler 2007, Parker & Crona 2012). Measures to improve the transparency of research coordination processes, and that of collaborative engagements with the response operation would have increased awareness of the NHRP's role, and significantly diminished confusion around decision-making criteria for research funding and participation.

Formalizing this information, and providing it in an accessible format on an open platform from the outset may have made the subsequent moratorium directive unnecessary. By diminishing the associated risk of alienating sectors of the research community, this would also have limited potential compromise to the legitimacy of the wider collaborative operation.

The widespread dissemination of decision-making criteria for research participation is arguably even more important when it comes to addressing the risks research pressure can pose to the response operation, and impacted populations. In the first instance, observance of the moratorium relied on dissemination to relevant researchers, who were more likely to adhere to it if the rationales for decisions made concerning research participation, and the exclusion of a proportion of interested researchers were clearly articulated.

No matter how widely voluntary measures are disseminated to researchers, however, there will always be those disinclined, for a variety of reasons, to accept the criteria for participation, and correspondingly reluctant to refrain from activity that does not meet those criteria. For this reason directives like that issued after the Christchurch Earthquake need to be communicated to those groups most likely to come under direct pressure as a result of increased research activity. Researchers, and the organizations they represent, can wield considerable authority. During the Canterbury earthquake sequence, a number of individuals and agencies sought clarification from local researchers, research organizations and the NHRP after being contacted by international researchers. Many were unaware not only of the moratorium directive, but also of their rights to refuse to consent to research participation detailed in the Belmont Report (1979). Concerns expressed included the expectation that research participation might be required of them, or of vulnerable populations in their charge, stress at the prospect of refusing researcher requests, and anxiety about the repercussions of refusals. These groups welcomed the moratorium directive, as it empowered agencies, researchers and potential research participants who so wished to decline requests from interested researchers.

The empowering effect of this directive was only available, however, to those potential research participants who were aware of it. To effectively reduce the risk of research pressure exacerbating the other stressors affecting impacted populations, research participation criteria and the participant rights provided in the Belmont Report need to be as widely disseminated as possible, through a variety of public channels. Given that some regions were without power for a considerable period, these channels should always include communication measures that do not rely on electricity, like door knocking and leaflet drops, which McLean et al. (2012) found to have been an effective means of communication after the Christchurch Earthquake. At the other end of the spectrum, including interactive and crowd-sourcing platforms wherever possible would allow generation of wider debate about the issue. Allowing those feeling pressured by research participation requests to contribute to and seek clarification from those coordinating research activities in the disaster zone, such platforms would also provide pathways for those wishing to take part in research activities (as either researchers or participants). Conversely, interactive data from agencies, researchers and potential and actual participants would also have the potential to help clarify the extent and nature of research activity in the impacted region, making it possible to develop new management measures in response to this developing picture.

3.5 Recommendations and conclusions

3.5.1 Recommendations

The following broad recommendations for research coordination during and after disasters can be extrapolated from this analysis.

3.5.1.1 The use of an existing, permanent research coordination organization

Research coordination after hazard events will be most effective if it is conducted by a permanent collaborative entity, with existing, closely related *usual* research coordination functions that facilitate the ongoing development of relevant

national research and end-user networks, and of networking skills. If such a consortium is not already in place, establishing it should be the first step.

3.5.1.2 Recommendations before disasters

Planning: The research consortium responsible for post-disaster research coordination should work with agencies responsible for emergency management to develop a detailed, collaborative disaster research coordination plan. The research plan should be fully integrated into the relevant response management structure. Resources should be allocated to research management activities. The research consortium should be made explicitly responsible for a distinct science function in the response structure, and provision should be made requiring consortium representatives to engage in regular emergency response training at local, regional and national levels with response agencies and other relevant organizations.

The research coordination plan should make provision for measures designed to facilitate a focus on - and the coordination of - as much research activity as possible in the relevant impacted region after hazard events. The aim should be to anticipate and plan to manage a surge in research interest that is roughly parallel to the profile of the relevant hazard event. Objectives should include mitigating the risks posed by this increased research activity, while also taking advantage of the possibilities it offers in terms of contribution to the wider effort, and the development of local research capacity and international research networks.

3.5.1.2 Recommendations after disasters

Integration With Response: Research coordination should be fully integrated with, and conducted in collaboration with the response operation.

Proactive Communication: As soon as possible after the event those responsible for research and emergency management should issue joint statements detailing research coordination responsibilities, processes, participation pathways, research

participant rights (to require proof of ethics approval, and to refuse consent) and measures to mitigate the risks associated with research pressure (such as collaboration and/or registration requirements). These statements should be officially formulated, and provide clear, accessibly phrased information. Relevant agencies should be included in ensuring that this information is as widely promulgated as possible – available on relevant open access websites, and included in media releases, leaflet drops, public meetings, interactive platforms and other communication channels used by the response operation.

Transparency: If possible, all research coordination decisions should be accessible on an up to date, monitored and appropriately resourced open website. Material provided should continue to include all broad decisions about research participation and the demarcation of tasks as they are made, as well as more specific information including research funding decisions, and relevant current and completed research projects and outputs in the impacted region.

Monitoring: All information gathered (from interactive websites, registration requirements, and agencies as well as through research funding decisions) should be used to monitor the wider research effort, with a view to responding to evolving research trends in order to maintain research quality, respond to emerging requirements and opportunities, and mitigate the risks associated with research pressure.

Building Local Capacity: Consideration should be given to involving highly qualified researchers from the impacted region with new interest in the hazard and disaster field, as much as possible, in order to develop local and national research capacity by bringing in new expertise.

3.5.2 Conclusions

Research activity after the Christchurch earthquake bears out findings from other disasters concerning the convergence of researchers into the disaster zone, and significant escalation of research activity. Within this increase in overall research

activity, research needs and opportunities were revealed in this post-disaster environment to be in tension with the risks posed to research quality by this increase, and to local agencies and populations. Active management of these tensions was necessary in order to address needs and maximize opportunities, while also reducing negative impacts on the larger response operation, local populations and research quality. However such management necessarily involved decisions about participation in research activity, which carried secondary risks associated with perceptions that groups had been excluded from participation. When not addressed, such perceptions have the potential to significantly compromise the legitimacy and the longer term validity of the larger research enterprise, and so can threaten gains made when it comes to addressing research needs and taking up opportunities created by the disaster. This allows us to conclude with five broad points about research coordination after disasters – all follow from the larger contention that such coordination is necessary.

In the first instance, research organizations are unlikely to be able to coordinate research activity in disaster zones without the involvement of disaster response agencies and organizations. This involvement is critical in order to address the research needs created by the disaster effectively, which often requires the engagement of these end-users. It is also required to minimize negative impacts of research activity on the wider response operation, and to facilitate researcher access to disaster zones. Conversely, response agencies are neither sufficiently qualified nor networked to effectively manage post-disaster research activity without support from the research community. To the extent that they are perceived to be doing so, they risk creating the perception that decision-making has ignored scientific considerations, and that the scientific community has been excluded from contributing to decisions that affect it directly. The first point, then, is that the risks and opportunities associated with post-disaster research activity can only be managed effectively to the extent that they are jointly managed, through as full and equal a collaboration as possible between the response operation and research communities.

This kind of joint, collaborative management of research activity will rely in turn,

however, on the range and relevance of the networks represented by both response and research operations, and which are thereby able to feed into decision-making in the chaotic and high pressure post-disaster environment. The New Zealand CIMS system is a purpose-built project management structure designed to effect this after disaster events by bringing together (and connecting back into) relevant government and other networks, at local, regional and national levels. The NHRP was barely established when this disaster struck. The extent to which it was able to organically develop a similar representative and networking function relied heavily on its ability as a national consortium to represent the research organizations demonstrating the greatest collective existing hazard and disaster research capacity at the time of the Canterbury earthquake sequence. Although not prepared for the post-disaster environment, the NHRP structure made it possible to bring this range of organizations together to effect collective decision-making about the coordination of research activity, by linking back through them into wider hazard and disaster research networks. Thus the second broad point we can draw from the Christchurch experience concerns the advantages of using a research consortium or platform structure to coordinate research activity after disasters. The more such a consortium draws on and represents the interests of wider research communities, the greater its capacity to ensure high quality research outcomes, and the less likely it is to create the perception that the interests of particular groups or organizations are being excluded as a result of decision-making about participation.

Thirdly, the corollary of this logic can be applied to the scope of research coordination after disasters. The wider this scope is, the less likely it is to generate perceptions of exclusion, even when a significant proportion of researchers wishing to participate are not able to do so. Including all research activity in the impacted region would also increase the possibility of monitoring the amount and nature of research activity in the impacted region, and so of managing it effectively.

The fourth point concerns the profile of the coordinating research consortium. The NHRP management group included internationally networked senior scientists

who represented – and relied on – expertise from all six member organizations. This group was responsible for all major NHRP decision-making concerning the coordination of research activity during and after the Canterbury earthquake sequence, including structural decisions about the demarcation of tasks and responsibilities, functional decisions concerning the scope and nature of research programs, and broad participatory decisions concerning engagement in research into this disaster and its aftermath. The extent to which collaborative research activity after the Christchurch Earthquake was informed by this larger decision-making body remained behind the scenes, however, due to the widespread collective assumption that attributed NHRP activity to GNS science. This attribution significantly limited the consortium’s ability to demonstrate the extent to which it in fact represented and was informed by the wider New Zealand (and international) hazard and disaster research community. To the extent that it increased the perception that a single organization was making decisions that influenced a range of sectors and organizations, it risked creating the impression that some of those directly affected by these decisions were excluded from both research management decision-making, and participation in research activities. The fourth point that emerges from the Christchurch earthquake experience relates to the extent to which research coordination arrangements are widely disseminated, transparent, and understood to at least some degree by all involved.

The fifth point to be drawn from the experience of research engagement after the Christchurch earthquake comes back again to the situation of the NHRP at the onset of the CES. Barely established, this consortium had not had time to develop extensive research networks, or generate a profile within researcher and end-user communities. As a pilot platform, it had no precedent to follow; with no resourcing for management, and without protocols and guidelines concerning coordinating research activity after disaster events, the NHRP was forced to evolve organically in response to this challenging environment. This situation can also be used, however, to make the obvious reverse point. Consortium status, collaborative decision-making relationships and structures, and links into wider networks were already in place when the NHRP was required to respond to this

disaster event. There is no doubt this played a major part in this consortium's considerable achievements after the disaster, which relied heavily on its ability to bring a wide range of expertise into decision-making around research coordination and into research programs and activities. It was also a major factor in the NHRP's ability to network across agencies at local and national levels to coordinate this research effort in collaboration with the response operation. The fifth point, then, which we can draw from the coordination of research during and after the Canterbury earthquake sequence, builds on the second. The advantages of using a consortium or platform structure to coordinate such research activity, in other words, will be significantly increased if this is an existing, well-established structure, with a relevant permanent research coordination function. The extent to which such a structure is able to fulfill its research coordination potential after disasters is likely to rely on the extent to which it is already engaged in the collaborative relationships – both within research communities, and with agencies and other relevant organizations – that become so crucial after disasters.

Finally, it is important to end by reiterating the point that has already been made in relation to other disasters, concerning the intense research pressure that follows such events, and the effects of this pressure on local research and emergency management communities, and on impacted populations. This pressure was considerable and difficult to manage after the Christchurch Earthquake, which, although a major disaster by New Zealand standards, was not a catastrophic event. After a catastrophic disaster, requesting that ambitious, senior researchers from prestigious institutions and organizations respect the need to defer data gathering visits becomes an infinitely more demanding task, and this level of difficulty increases exponentially again for researchers and response agencies in developing countries, due to North/South power relations (Sumathipala et al. 2010, Brown & Donini 2014, Citraningtyas et al. 2010). Increased awareness and discussion of this issue among hazard and disaster research communities is essential to ensure that visiting research teams respect moral and ethical research principles, and recognize the importance of being guided by the needs of local response operations, researchers and impacted populations when conducting research after disasters.

Changing demand for science support
after the 2011 Christchurch Earthquake: a case
study of the Psychosocial Recovery Advisory Group

4:1. Introduction

Literally definitive of chaotic decision-making environments (Van de Walle & Turoff 2008, Schloss 2014), major disasters disrupt social, institutional, environmental and geographical domains, creating extreme timeframes, high levels of urgency and rapid and differential changes in decision-making environments (Olshansky et al. 2012). Specialized institutional arrangements are commonly used to manage the increase in complexity created by this disruption. Facilitating emergency response, specialized management arrangements have also been found to be necessary to expedite medium to longer term recovery after major disasters (Johnson & Mamula-Seadon 2014).

Research activity has not been routinely included in activities managed as part of emergency response and recovery operations, although there are some precedents for restricting research access during such operations (Black 2003, Quick 1998, North et al. 2002, van Zijll de Jong et al. 2011, Beaven et al. 2015). The omission of research activity is surprising, since assessment and other research activities usually make major contributions to post disaster decision-making at the operational level, and in view of evidence that major disaster events can stimulate increased research interest (Gall et al. 2015, Liu et al. 2012, Taskin et al. 2010, Li et al. 2009), and collaborative activity between policy and research domains (Birkland 1998, Busenberg 2000B). This is consistent with Olshansky et al.'s (2012) finding that the sudden and unusual loss of capital services caused by such disasters creates a surge in demand for capital services, and an associated spike in demand for decision-making, information flows, financing and institutional formation (Chang et al. 2012, Johnson & Mamula-Seadon 2013). As urban development activities compress in both time and space, the post-disaster environment becomes "just real life, in all its complexities, on fast forward" (p.

177, Olshansky et al. 2012). Yet since processes of physical construction, social capital formation and institution building compress unequally (Olshansky et al. 2012), this environment differs in new ways, throwing new light on such processes. It follows that an improved understanding of arrangements used to manage support for the science/policy interface for decision-making after disasters will yield findings of value not only for those involved in responding to future disasters, but also for those involved in establishing organizational structures used to manage the science/policy interface in support of disaster risk reduction decision-making in relation to the urban development processes.

Recent work focused on the use of specialized arrangements to manage complex, multi-domain science/policy interfaces associated with large planning projects has established that decisions concerning the parameters of these arrangements influence the way they evolve (Verweij et al. 2014, van Meerkerk et al. 2012). There has been little research to date, however, into the use of such arrangements in support of the science/policy interface for decision-making after disasters, or the influence of the post-disaster environment on the development of such arrangements (exceptions include Birkland [1998] and Busenberg [2011]). This chapter is focused on the evolution of the Psychosocial Recovery Advisory Group (the Advisory Group). This small, short-term science advisory body was established in the aftermath of the 22nd February 2011 M_w 6.2 Christchurch, New Zealand earthquake by the larger research-coordinating consortium, the NHRP (Mooney et al. 2011). Linking the emergence and progress of the Advisory Group to changes in the extent and nature of demand for disaster-specific psychosocial knowledge after this event, the chapter aims to clarify the short to medium term influence of this event on both the science/policy interface and the disaster-related science domain in New Zealand. It is focused on the decision-making processes that gave rise to this group and guided its activities. This focus also allows a comparison to be made between the capacity of this small group and that of its larger, parent body, the NHRP, to adapt to the changing post-disaster environment. A further aim is thus to contribute to the emerging body of work establishing the influence of organizational parameters on adaptive capacity, by demonstrating the utility of this approach in the disaster risk reduction context.

It is important to note that this focus meant that issues of individual or organizational performance or responsibility fell outside scope. Neither does the chapter contain a comprehensive account or assessment of the Advisory Group and its activities, much less a critical review. It was based almost entirely on secondary data drawn from a substantial Advisory Group archive. Since Advisory Group tasks were carried out largely through email communications managed by the administrator, the archive includes email debates, edits to documents, and email requests and outcomes provided from and to Advisory Group clients, as well as a selection of other reference documents. The main advantage of this approach was the access it afforded to snapshot indications of thinking around decision-making as it occurred, since the material was generated over time, as part of Advisory Group activities. Reliance on the archive also minimized demands (for time, and focus) from those involved in this group.

4.2. Case study context

4.2.1. The Canterbury earthquake sequence

The Advisory Group was established in the aftermath of the 22 February 2011 M_w 6.2 Christchurch Earthquake, as part of the wider science/policy interface that evolved during the 2010-2011 Canterbury earthquake sequence. After the Christchurch Earthquake, this interface was focused through three large collaborative arrangements. The Christchurch Response Center was established on the 24th February 2011, and deviated from existing New Zealand response plans by bringing central, regional and local levels of government response agencies together into a new collaborative structure, based in a single geographical site in the center of the impacted city (McLean et al. 2012). On the 1st of May 2011, the Canterbury Earthquake Recovery Authority (CERA) took over responsibility for recovery strategy from the CRC operation. Established on the 19th April under legislation passed on the 14th of that month through the Canterbury Earthquake Recovery Act (CER) 2011, CERA was a purpose-designed

initiative, and reported directly to the Minister for the Recovery. This new central government authority was based in Christchurch, rather than in Wellington, the seat of government, and so brought central and local levels of government agencies together to oversee strategy and operations from within the disaster-impacted city (Johnson & Mamula-Seadon 2014).

New Zealand's NHRP was the third of these large collaborative arrangements. Responsible for coordinating collaborative research support for the government after major events, it was the official science interface within the Christchurch Response Center, and subsequently CERA (NHRP 2009A).

4.2.2 The scope of the NHRP

Launched in 2009, the NHRP was a pilot platform, set up to trial the national research platform concept by managing a complex issue across multiple domain boundaries (NHRP 2009A). Structured to bring together and integrate research organizations with existing natural hazard and disaster research capacity but distinct existing priorities, this arrangement was also tasked with integrating relevant disciplines into five broad thematic areas (Figure 5, p 33 above). The NHRP Strategic Advisory Group integrated the research arms of this structure with agency and other relevant end-users, in keeping with guiding principles that prioritised research issues raised in particular government agency strategies, the endorsement of research programs by end-users, including government agencies, and (where possible) the involvement of such end-users in all stages of the research design process (NHRP 2009A).

This background, together with continuing administrative and governmental spheres of responsibility dictated that the NHRP aligned with a particular and narrowly defined group of government agencies, those awarded responsibility "for reduction, readiness, response and recovery from natural hazard events" in New Zealand natural hazard management and security policy and legislation (p. 3, NHRP 2009B). Set up to further the Crown vision already articulated in that context, the NHRP was to work towards "a New Zealand society that is more

resilient to natural hazards” – “specifically earthquakes, landslides, volcanic eruptions, tsunami, floods, severe winds, snow, [and] coastal erosion” (p. 3-5, NHRP 2009B, CDEM Act 2002). Other manmade (industrial, biotechnical and terrorist) sources of hazard and risk were specified as outside NHRP scope (NHRP 2009B). Sources of health hazard and risk (such as pandemic risk) were deemed so far outside this scope that they were not mentioned at all in strategy documents.

This limitation on scope corresponded to the larger administrative distinctions that awarded responsibility for distinct hazard categories to discrete agency groupings, and in this way facilitated the NHRP’s ability to interface with those agencies responsible for natural hazard and risk management. The narrowness of this scope was potentially inconsistent, however, with that of the NHRP’s crosscutting themes, risk evaluation modeling and social resilience. In addition to cutting across the other, more traditional natural hazard disciplinary categories included in the NHRP, these themes extended into areas beyond the consortium’s official scope. Societal resilience, in particular, included psychosocial resilience, which reached into the realm of individual and public health. Research and knowledge concerning medicine and public health fell under the aegis of New Zealand’s Health Research Committee, which reported to the Ministry of Health. It was thus the domain of a completely different agency grouping, including this department, regional health boards and local general practitioner organizations, among others. During the Canterbury Earthquake Sequence this grouping activated its own emergency management arrangements, which amounted to a parallel and interlinked structure with response and recovery operations, at national, regional and local levels (McLean et al. 2012).

The inconsistency between the NHRP’s societal resilience theme and the NHRP’s official scope came to the forefront after the Christchurch Earthquake, when NHRP researchers with psychosocial expertise were approached by agencies requesting disaster-specific advice. Designed to bring existing hazard and disaster research expertise into a closer relationship with relevant agencies, this then-newly established body made the decision at that point to negotiate the potential inconsistency with the NHRP’s official scope by addressing this agency need by

establishing the Advisory Group. This specialized psychosocial recovery advisory body remained semi-discrete, and operated in parallel with other NHRP activities.

4.2.3. The formation of the Advisory Group

The Advisory Group was established by and through the NHRP in early March 2011, almost two months before the establishment of CERA. Minimal funding through two small grants (one from a Wellington agency and the other from the NHRP) covered basic administration costs until mid-2012, when Advisory Group activity in effect ceased. Since scope issues complicated explicit links with the NHRP operation, this group was based in the Joint Center for Disaster Research (the Center). This center is a collaborative venture between two NHRP member organizations, Massey University and GNS Science, which is the Crown Research Institute responsible for a range of hazards related research in New Zealand. Prior to the earthquake sequence the Center had undertaken most New Zealand research in the area of psychosocial disaster resilience. The Center director had been appointed as the NHRP social science theme leader in 2009, and another senior academic based in the Center also had a history of intensive consultation with NZ agencies (including the Ministry of Health) in relation to pandemic planning and other policy related to psychosocial risk, resilience and recovery.

Active on the borders of a range of organizational structures in the science/policy interface concerned with disaster risk reduction before the earthquake disaster, both these scientists were thus already boundary spanners. Boundary spanning has been defined as the development of multiple connections across organizational and domain boundaries to build trust and improve coordination around decision-making and implementation in governance networks concerned with complex public issues (van Meerkerk & Edelenbos 2014, Parker & Crona 2012). The networks developed by these Center scientists before the earthquake sequence (including NHRP activities) made them an early point of contact for agencies requiring psychosocial advice after the Christchurch Earthquake. Instrumental in the establishment of the Advisory Group, both engaged simultaneously in Advisory Group activities and in other aspects of the

collaborative research response coordinated by the NHRP. The Advisory Group was thus a specialized, semi-discrete component in the much larger suite of advisory and other research activities coordinated by the NHRP as part of its collaboration with government response and recovery operations (Figure 12).

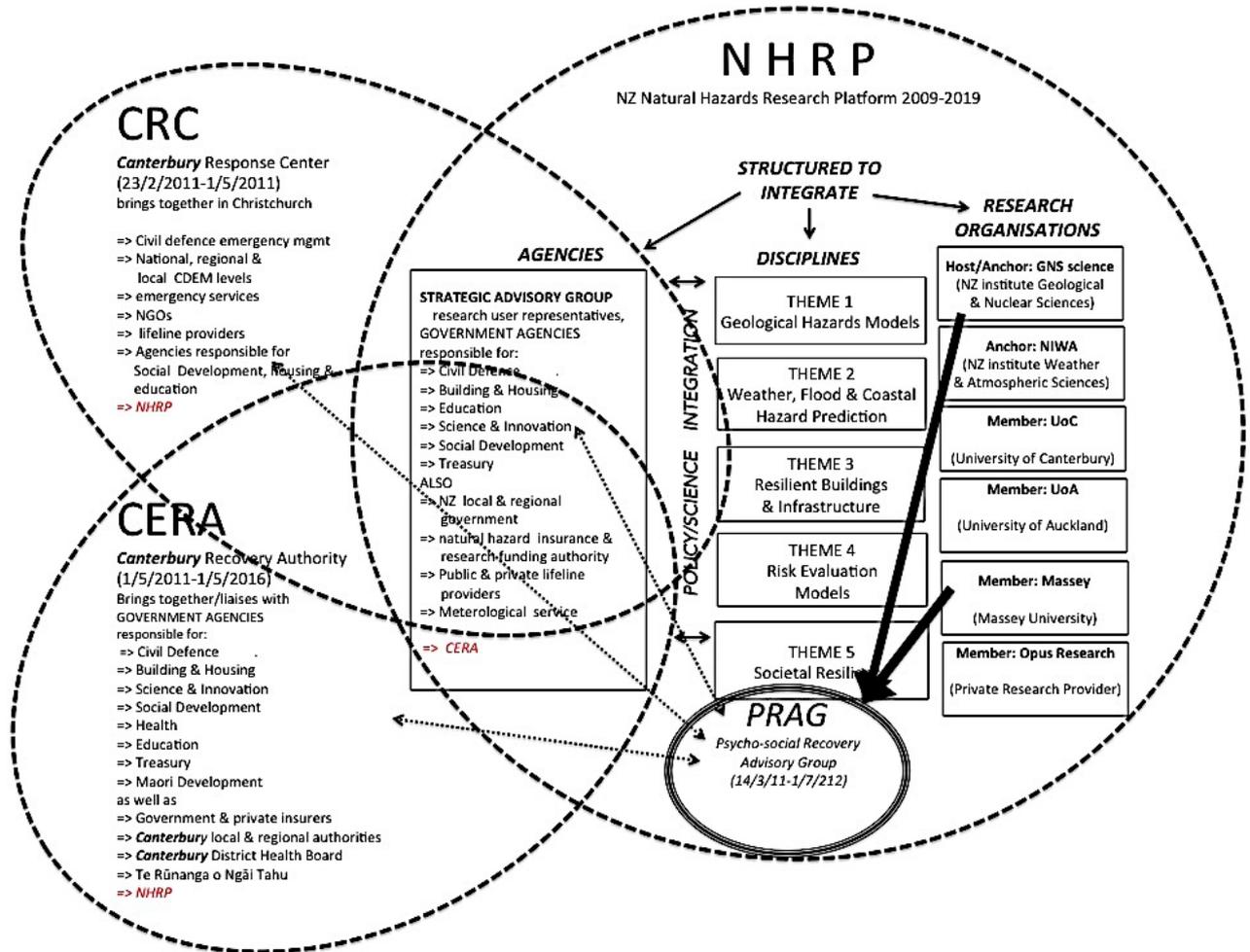


Figure 12: Overlapping coordinating structures used to support the science/policy interface after the CES disaster.

The speed with which this group emerged and began to function after the Christchurch Earthquake thus illustrates the capacity of boundary-spanning individuals to draw on existing research and policy networks to set up advisory groups of this kind in such short order after a major event. It thereby also underlined the role played by NHRP in developing these pre-existing cross-sector networks before the Canterbury Earthquake Sequence, and so facilitating these early boundary-spanning roles. Most of all, however, the rapid emergence and

activity of this advisory group reflects the time compression and associated urgency that characterised this post-disaster disaster environment. It is clear from the chronological distribution of tasks that the greatest agency demand for Advisory Group services coincided with the state of national emergency (see Table 6: Appendix 3). From inception on the 11th March 2011 until the 15th of April 2011, the day after the CER Act was passed, the Advisory Group received and had largely processed nine of a total thirteen agency requests for scientific advice (see Table 6: Appendix 3). By July 2012, however, when the Advisory Group was effectively discontinued, it had only received four further agency requests for scientific advice. This indicated a rapid fall off in agency demand for its services as responsibility for recovery strategy shifted from central agencies in Wellington to the new central government authority based in Christchurch (see Table 6: Appendix 3). A closer look at the parameters that dictated this advisory group's engagement with its wider environment helps to clarify the relationship between these parameters and the rapidly changing decision-making environment, and the role of this interaction in both the rapid operationalization of this group, and subsequent cessation.

4.3 Method

4.3.1 Theoretical Framework

The analysis that follows relies on a constructivist approach developed in the resource management context. There it has been applied to planning project management arrangements established to manage the additional complexity caused created when existing boundaries are being redrawn in already highly complex multi-domain environments (Verweij et al. 2014, Van Meerkerk et al. 2013). Recent studies in this area have established that decisions made about the boundaries or parameters of such arrangements can introduce new issues into the complex environments they have been designed to manage (Verweij et al. 2014, van Meerkerk & Edelenbos 2014, van Meerkerk et al. 2013).¹⁰ The extent to which

¹⁰ Note that this is more usually termed 'boundary decision-making' in the relevant

judgments and decisions made about project parameters are exclusive or inclusive has been found to influence organizational capacity to adapt in response to such issues, and also to issues associated with changes in decision-making environments (van Meerkerk et al. 2013). The establishment of the Advisory Group, for example, can be considered an adaptive response to issues created by the exclusion of health-related research in the official NHRP scope. Limiting NHRP scope to the hazards listed in the strategy document, this parameter was narrower than the NHRP social resilience theme. On the other hand, however, this exclusive scope had the advantage of facilitating NHRP engagement with those agencies responsible for managing natural hazard risk.

Verweij et al (2014) identify four categories of parameter that can have determinative effects of this kind; those that delimit participation, function or scope, structure and geographic territory (including focus and location). This chapter also considers funding as a limiting parameter. Distinguishing the Advisory Group from the wider post-disaster environment, these interconnected parameters influenced the nature and extent of Advisory Group engagement with agency demand after the disaster. Judgments and decisions concerning participation determined which individuals and organizations were involved in the Advisory Group, how they were involved, and how the Advisory Group dealt with the involvement of others involved in response and recovery operations (Ashmos et al. 2000, Edelenbos & Klijn 2006). Participation decisions relied on, and also informed, decisions concerned with the Advisory Group's function, or substantive scope (van Meerkerk & Edelenbos 2014). Since this was the provision of specialized psychosocial disaster recovery advice to relevant government agencies, Non-Governmental Organizations (NGOs) and others, Advisory Group members were required to be qualified accordingly (PRAG 2011). Conversely, Advisory Group function continued to be both defined and limited by the combined qualifications and capacity of members, and so by participation

literature (Verweij et al. 2014; Van Meerkerk & Edelenbos 2014; Van Meerkerk et al. 2013). In this chapter however the term 'boundary' is reserved for the boundaries of larger (external) domains, to avoid confusion between the latter and the delimiting parameters of post-disaster management arrangements like the Advisory Group, the Christchurch Response Center and CERA.

parameters. Ongoing structural judgments and decisions concerned with the demarcation of tasks and responsibilities (Ashmos et al. 2000, Verweij et al. 2014) informed and continued to be informed by both participation and substantive considerations. Territorial decisions, involving both the geographical focus of Advisory Group activities, and the geographical location in Wellington gained greater and changing relevance in relation to both participation and scope as time went on.

This chapter is concerned with a single case study, focused on a small scientific advisory group's decision-making concerning the extent and nature of its role after a major disaster. The use of a specific case means that findings cannot be used as the basis of generalized empirical knowledge; case studies can, however, provide a more detailed understanding of a phenomenon of interest (Stake 1995). Clarifying how decision-making and judgments concerning the parameters of this advisory group and its activities can be related to the capacity to adapt in response to rapid changes in the post-disaster environment, this case study also provides insights into shifts in agency demand for science engagement and changes in the natural hazard and disaster research domain as emergency response transitioned into recovery.

4.3.2 Materials

The chapter is based on data drawn largely from secondary documentation generated as part of Advisory Group activities, which were conceived and managed by members as a series of tasks carried out largely through email communications managed by the administrator. The bulk of this data is a large archive containing more than two hundred and fifty emails – between Advisory Group members as well as to and from clients – and other relevant documents, including responses to client requests, Terms of Reference, meeting agendas and minutes, shared references, and funding documentation. The archive was compiled by the Advisory Group administrator in 2011 and 2012, and held by the Advisory Group Chair. Access to this archive was granted after obtaining consent from PRAG members and clients for its use for the purposes of this research

project only. Observational data from members of the supervisory team involved in Advisory Group activities also informed the analysis.

In preparation for analysis emails and other documents were organised on the basis of task and for each task items were organized in a time sequence. Twenty tasks were identified. Of these, thirteen were initiated in response to direct agency request, four were self-initiated, and the remaining three consisted of a request for rapid commentary from a private organization, and New Zealand Psychological Society invitations to present and publish overviews of psychosocial recovery (Table 1). The analysis was concerned with decision-making concerning Advisory Group parameters. For this reason, it drew more heavily on material relating directly to such decision-making (particularly the Terms of Reference tasks). Relevant material was also drawn from emails and other documentation concerning the thirteen tasks initiated as a result of agency requests between March 2011 and August 2012.

4.4. Analysis

4.4.1 Decision-making concerning initial Advisory Group parameters

The Advisory Group became active just over two weeks after the Christchurch Earthquake, and so at a time in which post-disaster time-compression was still very high. Advisory Group parameters thus to a large extent fell back upon and made explicit pre-disaster advisory and networking arrangements, reflecting its rapid formation as a pragmatic response to the fact that psychosocial recovery fell across – and therefore partially outside – NHRP scope. Emerging out of existing relationships developed through the NHRP, and positioned in the Center, the Advisory Group was able to provide advice from those already recognised, in government circles, as leaders in the field of psychosocial recovery. The decision to base the Advisory Group in the Center was also consistent with the founding NHRP emphasis on existing disaster research expertise. Prior to the onset of the Canterbury earthquake sequence, the majority of New Zealand's research capacity

in disaster-specific psychology and psychosocial resilience was conducted in this Center.

The need for timely policy-relevant information has been found to be in fundamental tension with time-consuming consensus-building processes under normal conditions (Sarkki et al. 2014, Parker & Crona 2012, Hackett 1997, Fordham 2007). It follows that the reliance on existing networks made explicit through the Advisory Group is likely to be particularly symptomatic of post-disaster time-compression, which immediately after the disaster limited both the development of new networks across this science/policy interface, and the gathering of in-depth scientific evidence drawn from the disaster that had just occurred. Early Advisory Group tasks indicate that, with minimal time to develop response and recovery strategies and operations, and under pressure from those wishing to engage in the response operation, national level agencies required existing knowledge, derived from other disasters, rapidly delivered in an accessible form. This equated to a need for support from disaster-specific research specialisations. Early agency requests are consistent with this. Four of the six agency requests made in March 2011 were for specialist advice on aspects of the involvement (or proposed involvement) of local and international volunteers or contractors in the response operation. The other two were a request for rapid specialist commentary on a psychosocial recovery strategy and national planning framework in late March, and the initial request, from the Ministry of Social Development, for Terms of Reference outlining the purpose and structure of the Advisory Group (Mooney et al. 2011).

Completed in the first two weeks of Advisory Group activity in parallel with other March tasks, the Terms of Reference document and associated emails outline parameters that strongly reflected agency need at this point after the disaster.

4.4.1.1 Function – substantive scope (what was the function):

Early discussions and documents concerning Advisory Group function are consistent with a traditional model of scientific advice provision, in which advice

concerning a specific issue is requested from specialist experts. The initial Terms of Reference (finalized on the 24th of March 2011) referred to the provision of independent “academic or clinical” judgment or advice, focused on psychosocial support and recovery. Referring specifically to “commentary on particular policy recommendations” in this context, this early document included an outline of the areas in which advice might be provided: psychosocial interventions, risk communication, implications of changes to the built environment, review of data and research on offer to clients, and community resilience (p.1, PRAG 2011).

Advisory Group tasks clarify that agency requests almost all fell well inside the initial scope set out in the Terms of Reference (Table 6: Appendix 3); nine of a total of 13 agency requests required rapid commentary. Of this nine, three required feedback on broader recovery policy strategic documents, while a further three involved commentary on proposed government interventions that fell broadly into the community resilience category. Three early requests were for commentary on international requests for funding and access to engage in response or recovery activities. Two further agency requests were for varieties of literature and research review. This was also the focus of self-initiated tasks, particularly those involving the extended development of the Terms of Reference and the supplementary psychosocial annex document summarizing current findings in this area. The request for a presentation and paper on psychosocial recovery from the Psychological Association also fell into the literature and research review category (Table 6: Appendix 3).

The remaining two agency requests fell outside this initial scope, and also in effect framed this early phase of Advisory Group activity in time. The first request for the founding Terms of reference preceded that scope; initiated after a Ministry for Social Development request on March 11th 2011, this document was delivered to the Ministry on March 24th. The tenth request concerned the development of an existing Ministry of Social Development project concerning the identification of reliable recovery measures (Mooney et al 2011). The last request from a Wellington-based agency, this task was initiated less than a week before the CER Act on April 14th made it clear that monitoring and other recovery responsibilities

would become the preserve of the new Christchurch-based CERA later the same month.

Although in effect rendered moot by this development, Advisory Group discussions of this tenth request continued into May, revolving largely around the implications of the scope extension that would be required to engage in such a project. Some members were enthusiastic about extending the group's scope to include a much wider, holistic interpretation of psychosocial recovery, able to incorporate – and more comprehensively explore – the interface between mental health interventions and community recovery. Concerns expressed by others included the Advisory Group's financial and time constraints, and were also focused on the risk that such an extension had the potential to aggravate a perceived tension (in the existing scope) between knowledge and interventions concerned with individual psychological recovery and a wider emphasis on community recovery. This was described (in email discussions and in meeting minutes) as the risk of the scope becoming so divergent as to make the Advisory Group unworkable.

4.4.1.2 Participation parameters – (who were members):

Early in March 2011, the newly appointed administrator sent emails to an initial five founding members; by the time the first Terms of Reference document was finalized and provided to government agencies, there were six founding members. Initial formulations limited membership to those with recognised expertise in psychosocial dimensions of post-disaster recovery (Terms of Reference 2011). All founding members were qualified in the field of psychology and had either practiced and or published extensively in this discipline. In addition, these initial criteria required members to have disaster-specific disciplinary expertise.

The Terms of Reference referred to agencies, NGOs and others involved in recovery operations as Advisory Group clients, rather than categorizing them as Advisory Group members. It also indicated that where applicable the Advisory

Group would draw from the broader pool of expertise offered by wider research, clinical and practice communities.

The workload associated with the initial nine tasks was considerable, and two further members, a senior academic and a practitioner with psychology qualifications and relevant experience in the agency sector, joined the Advisory Group in early April. In effect, the addition of these new members extended the initial membership criteria to include disaster-specific sociological planning and practical expertise relating to community resilience. A third member invited to join the group later in April was a senior psychology academic with little disaster-specific expertise prior to the Canterbury earthquake sequence. In effect, this extended the membership criteria to include psychological qualifications per se; in June of the same year, two more psychologically qualified members with no disaster-related experience prior to the Canterbury earthquake sequence joined the team, bringing the total membership up to eleven. The expansion of the early membership criteria can be represented in a matrix (Figure 13)

Categories of Expertise	Disaster specialisation (prior to CES)	No disaster specialisation (prior to CES)
Psychology: psychosocial individual (& community) resilience	Initial (founding) members (6)	Subsequently added members (3)
Planning/sociology: psychosocial (individual & community) resilience	Subsequently added members (2)	(no added members)

Figure 13: Changes in Advisory Group membership criteria as a matrix.

Discussions were initiated in early April by new members, in the context of the

request concerning recovery measures, concerned with the possibility of including a much wider range of sociological and other scientific expertise, as well as agency and other stakeholders as members, rather than clients. These, however, were resolved with reference to agency demand for comparatively narrowly specialized psychosocial advice, on the one hand, and on the other in relation to the risk of duplication with other NHRP activities. These debates about membership criteria revolved, like those concerning scope, around the need to balance the importance of providing scientifically credible advice concerning recovery needs at both individual (psychological) and community (sociological) levels, against the risk that extensions of membership criteria might render the Terms of Reference, associated documentation and the Advisory Group itself so divergent as to be unmanageable.

4.4.1.3 Structure (how did the Advisory Group function)

The Advisory Group was structured with the Chair as the primary liaison point with agencies. Requests were passed from the Chair to the administrator, who distributed the request and managed subsequent iterations of the response document via group emailing with and between members, supplemented by fortnightly meetings for those who could attend. Once the collated advice document had incorporated a consensus of advice from members, it was provided by the administrator to the Chair for final comment and approval, who then passed the final document on to the agency (note that as the Advisory Group developed, advice requests and outcomes documents were sometimes exchanged directly between agency representatives and the Advisory Group administrator, although the Chair was kept in that loop).

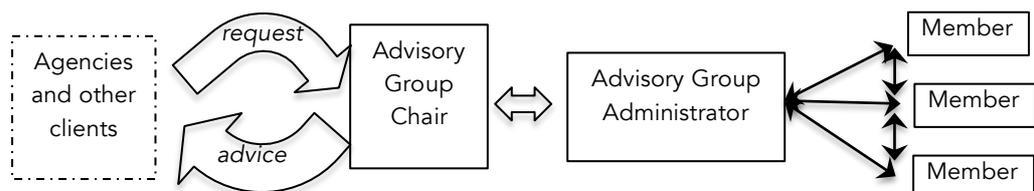


Figure 14: Diagrammatic representation of the Advisory Group structure

This structure was a pragmatic and effective response to the immediate pressures created by this early disaster response environment (Figure 14). Since the Chair was already networked with a range of government agencies, he was likely to be the first point of contact for agencies requesting advice in any case. The Advisory Group structure thus ensured that agencies were able to interface directly with someone they already knew, so reducing demands on their time, while maximizing the collaborative opportunities arising out of these relationships. It also managed the steep increase in demand for psychosocial recovery advice from Wellington agencies immediately following the Christchurch event by distributing the resulting workload across a number of similarly qualified experts. The structure also reflected the minimal funding provided for Advisory Group activities. Only the administrator and one other Advisory Group member were funded (both on a part time basis). Other Advisory Group members (including the Chair) provided input free of charge. This structure thus placed the largest workload on the administrator position. The distribution of the bulk of discussion and writing work across a range of members reduced the work required of any one member, and kept work for the chair to a minimum by removing him from the majority of the discussions.

The narrowness of this structure, which minimized contact between the agencies requesting advice and the members who developed it, and also cut down email contact between members and the Chair thus was well suited to the early agency need for the rapid provision of existing disaster-related knowledge, in an accessible form, through networks that predated the event.

4.4.1.4 Territory (geographical focus and location)

Advisory Group terms of reference clarify the geographical focus, since the recovery advice was to be related specifically to the recent sequence of earthquakes in Christchurch. Although not explicitly mentioned in the body of this document, the Advisory Group's location was indicated in the preamble to the Terms of Reference, which placed it in the Center, in Wellington. Since this city is

the seat of New Zealand government, this location had been a significant factor in the development of collaborative NHRP networks and research programs involving national agencies, and facilitated the boundary spanning activities of its senior scientists; it also meant that the Center was already recognised by Wellington agencies as a center specializing in psychosocial disaster resilience.

Ensuring the Advisory Group was well placed to engage with national agencies in Wellington, this location left it less well positioned in relation to the focus on recovery from a Christchurch disaster. Even in the early stages of activity, non-Advisory Group Canterbury earthquake sequence related advisory and research tasks required that several members spent considerable amounts of time physically present in Christchurch. Minutes from early April meetings, for example, include reports from members concerning attendance at a selection of the rapidly proliferating activities (including psychosocial wellbeing planning sessions, community meetings, and research and other forums) being conducted in the impacted city at the time. Concerns were expressed in these meetings about the need to significantly increase Advisory Group involvement in these and other response activities, by further increasing the physical presence of members in the impacted city. Since all Advisory Group members were still based in (or linked to) Wellington rather than Christchurch, this presented ongoing logistical challenges, including the need to arrange and fund flights and accommodation for what amounted, for some members, to ongoing commuting arrangements. The recruitment, later in 2011, of new Advisory Group members drawn from Christchurch organizations represented an attempt to address this geographical issue. Agency demand for Advisory Group advice, however, fell off almost immediately after the passing of the CER Act on the 14th April 2011.

4.4.2 The Advisory Group and the NHRP in the changing post-disaster environment

The Advisory Group arose out of separating psychosocial recovery out from the larger NHRP research operation as a component problem effectively considered in isolation, with advice subsequently incorporated by policy and decision-makers

into other problem fields (Axelrod & Cohen 1999, cited in van Meerkerk et al. 2013). It has been established that this kind of approach usually requires narrow or exclusive parameters, and predominates in projects established to minimize and thereby manage complexity in longer-term environmental and urban planning contexts (van Meerkerk & Edelenbos 2014, Axelrod & Cohen 1999, cited in van Meerkerk et al. 2013). A pragmatic response to the issues created by the NHRP scope limitation concerning health issues, the narrowly focused Advisory Group was thereby fit for purpose. It is to be expected that a group formed in the immediate aftermath of a major disaster should establish parameters aimed at reducing the increase in complexity that is definitional of chaotic decision-making environments, particularly since they were so well suited to the needs of its main Wellington-based agency client during the early response phase. These parameters, in other words, ensured that the Advisory Group was able to render existing psychosocial disaster advice networks explicit, in order to provide existing commentary and knowledge in an accessible form from scientific experts with existing disaster specialisation.

It has been established, however, that over the medium to long term narrow parameters designed to minimize and so manage complexity can hinder ability to adapt to changes in the wider environment (van Meerkerk & Edelenbos 2014, Van Meerkerk et al 2013, Verweij et al. 2014). The dramatic drop off in agency requests for Advisory Group services after the CER Act was passed on April 14th 2011 indicates that one of the more significant changes affecting this post-disaster environment was the establishment of CERA in Christchurch. Existing CDEM plans had allowed for the top tier of agencies involved in response and recovery to manage both strategy and operations from Wellington (Johnson & Mamula-Seadon 2014, McLean et al. 2012). Such an arrangement may have ameliorated the abruptness of this decline in demand for Advisory Group services.

4.4.2.1 Changes in demand for science support

The topic area that most clearly exemplifies the changing demand for science support from agencies in the early recovery period is recovery monitoring. This

was first raised as the Ministry of Social Development's early request concerning the development of reliable social recovery measures (Mooney et al. 2011). In hindsight this appears to have been the first indication of what rapidly emerged as a shift in the focus and type of science support required by agencies beginning to engage in the recovery. This request was initiated at a time when this ministry was the lead social recovery agency (Gluckman 2011). A week later the CER Act 2011 awarded this responsibility instead to CERA, which meant the Advisory Group's collaboration with the Ministry of Social Development in this area concluded, in mid-May, in discussions concerning the wording of the recovery monitoring section in this agency's Recovery Strategy.

It was inevitable that agencies involved in the social recovery operation would turn their attention to the need for reliable ways to measure recovery progress. In the months after the Christchurch Earthquake several discrete parallel initiatives had already begun to emerge in this area. The role of the Advisory Group in these was limited to minimal and indirect influence at the very earliest stages of each initiative. To understand why this role was limited, it is useful to briefly summarise the way these initiatives developed in parallel through 2011 and 2012.

As the new lead social recovery agency, CERA strongly drove the development of the social component in its own wider recovery monitoring and implementation framework (<http://cera.govt.nz/recovery-strategy/overview/monitoring-reporting-and-review>) throughout 2011, launching it early in 2012. The resulting program is well documented in the public domain. It includes both the Canterbury Wellbeing Index (<http://cera.govt.nz/recovery-strategy/social/canterbury-wellbeing-index>), which gathers big data from relevant existing agency data streams to monitor recovery progress, and the ongoing CERA Wellbeing Survey (<http://cera.govt.nz/wellbeing-survey>), which supplements the Index with self-reported data gathered six-monthly from Greater Christchurch residents since April 2012 (Morgan et al. 2015).

The Advisory Group's involvement in the wide consultation networking used by CERA to drive the development of this program in 2011-2012 was minimal,

occurring largely at a second remove, through the two scientists who were not engaged in these networks as Advisory Group members, but rather through the NHRP. Officially mandated to coordinate science in support of the recovery operation, the NHRP was invited to take part (as one of many stakeholders) in the intensive series of workshops through which CERA identified the most relevant existing data streams for inclusion in the Canterbury Wellbeing Index; it was also involved in this capacity as a collaborative partner in the CERA Wellbeing Survey project, which it also co-funded (Morgan et al. 2015).

The Canterbury District Health Board was similarly involved in the development of the CERA program, supplying data for compilation into the Canterbury Wellbeing Index, and partnering in the CERA Wellbeing Survey project. Although drawing from the data and findings of this program to inform its decision-making, this agency was also developing a monitoring program focused on the health domain. To this end it commissioned an early literature review of existing knowledge in this area. Completed in 2011, this review was entitled 'Designing indicators for measuring recovery from disasters' (Bidwell 2011), and shared with CERA during the development of the Index. A related recovery monitoring and implementation program was launched in the health field early in 2013 to supplement and function alongside CERA's social recovery monitoring program. Funded by the Ministry of Health and CERA, and entitled 'All Right? – Is Canterbury All Right?' this high profile public program is also well documented in the public domain. In addition to ongoing monitoring research activity, it includes the range of recovery projects and social media campaigns detailed on the "All Right?" website (<http://www.allright.org.nz/>; www.healthychristchurch.org.nz/priority-areas/wellbeing-and-community-resilience/all-right-wellbeing-campaign.aspx). Led by the New Zealand Mental Health Foundation and the District Health Board under the Healthy Christchurch banner (<http://www.healthychristchurch.org.nz/>), the program cites the Greater Christchurch Psychosocial Committee, and the Chief Science Adviser's 2011 psychosocial briefing paper on its website as original catalysts (<http://www.allright.org.nz/>). The cited committee is one of the collaborative forums hosted by CERA as part of its Wellbeing program. The briefing paper was a synopsis of existing findings in the field compiled by the

Chief Science Adviser early in 2011 (Gluckman 2011); support from the Advisory Group for this synopsis was the ninth Advisory Group task (Mooney et al. 2011). The Advisory Group Chair was also a founding member of the All Right? Advisory Group.

The website acknowledges Ministry of Social Development support for the All Right? program. Although not the lead social recovery agency, this agency continued to be very active in the recovery operation. At the same time, in order to develop a national social recovery-monitoring framework in preparation for engagement in future disasters, this ministry initiated a new round of discussions later in 2011. Although conducted with their existing contact, the Advisory Group Chair, these discussions did not include prospective Advisory Group involvement. Instead, the outcome was a distinct, ongoing medium to long-term research project, commissioned and funded by the Ministry of Social Development to develop a national recovery-monitoring framework. This project is collaborative, based in Christchurch, and draws heavily on both the CERA and Ministry of Health recovery monitoring and implementation frameworks and associated data (Pers. Com. S. Johal 2015).

Two points can be made about these three social recovery-monitoring initiatives. Firstly, Advisory Group influence on all three appeared to consist on the one hand of carry-over from activity conducted during the late response phase, and on the other, to have occurred at a second remove, as part of the ambiguity arising out of the on-going boundary spanning activities of the two scientists who originally established this group, and went on to engage in these new projects in different capacities.

Secondly, despite the many differences between these three initiatives, all manifest similar key characteristics concerning the science/policy interface. All gather, and are based on, data concerning recovery from the Canterbury earthquake sequence, and so are focused on developing knowledge of this disaster from evidence gathered in its aftermath. All are large programs, and include ongoing research projects as components in larger, ongoing agency-

driven multi-stakeholder collaborative programs. All include the implementation of research outcomes in recovery planning and other decision-making. Finally, these projects are interlinked, largely because they were developed as part of – and through – the new round of consensus building involved in the emergence of new recovery networks in Canterbury. As the social recovery gained momentum, these new networking arrangements connected into, expanded, incorporated and replaced those that had pre-existed the disaster (Table 3).

	Initial period (response) PRAG parameters	Ongoing demand (recovery) Beyond PRAG parameters
<i>Function - substantive scope</i>	Provision 'academic/clinical' advice and judgments concerning existing knowledge of psychosocial support & recovery (derived from other disasters)	Large longer term recovery projects Focus on big data concerning <i>this disaster in particular</i> ; translation of data into new knowledge, policy and practice
<i>Participation: who is involved and how</i>	Narrow 'expert membership' criteria: disaster-specific psychological qualifications	Stakeholder Representation <ul style="list-style-type: none"> • Agencies & practitioner, community and other stakeholder groups • Research disciplines/specialisations
<i>Structure: apportionment of tasks & responsibilities</i>	Advice delivery model: incoming agency requests/tasks; expert consensus advice delivered as output	Multi-stakeholder agency-driven collaborations derived from and developing new disaster-related networks
<i>Territory - geographic focus & base</i>	Christchurch focus ; Wellington base and networking (seat of government) <ul style="list-style-type: none"> • Wellington based/linked members • engagement Wellington agencies 	Christchurch focus, base and networking <ul style="list-style-type: none"> • largely Christchurch-based members • projects driven by Christchurch agencies • researchers active in Christchurch

Table 3: Changes in agency demand in relation to Advisory Group parameters

4.4.2.2 Adaptive capacity and parameter width

The consistency of this shift away from the requirements that characterized the first phase of agency demand for science support is particularly clear when compared with Advisory Group parameters established in the immediate aftermath of the Christchurch Earthquake (Table 3). The initial scope allowed for the provision of expert commentary and reviews of existing knowledge derived from previous disasters; these recovery programs however were focused on the development of new knowledge based on new evidence concerning this disaster. The PRAG's initial participation criteria required members with both academic/clinical psychological qualifications and existing disaster specialisations. Participation parameters in these later recovery monitoring projects were much wider, including a range of stakeholder representatives and disciplines. Pre-existing disaster specialisation – although still necessary – became less critical as the focus turned increasingly to research and data gathering related to this disaster. Finally, the base of the Advisory Group in the Center had made explicit existing disaster-related science/policy networks in Wellington, the seat of central Government. Subsequent monitoring initiatives, by contrast, involved the new round of consensus building in Canterbury as new recovery networks developed in the impacted city (Table 3).

This change across so many aspects of the disaster-related science/policy interface effectively put all this group's parameters under pressure. Email exchanges and meeting minutes make it clear that, when the Ministry of Social Development first raised the issue of recovery measures in early April, it was immediately apparent to members that engagement in such a project was out of scope. The parameters set out in the Terms of Reference effectively limited the Advisory Group to providing commentaries and reviews of existing knowledge. Scope extension discussions covered the possibility of including a much wider, holistic interpretation of psychosocial recovery and the requisite extension of membership criteria to include research leaders from a much wider range of disciplinary fields. These discussions also considered an associated extension of structure to facilitate the establishment of a psychosocial recovery hub function,

which would bring together the parallel strands of related research and policy activity that were rapidly emerging in the wake of the disaster. The existing structure however meant that these discussions remained, like Advisory Group tasks, in-house, rather than involving broader research and recovery environments. They also gave rise to concerns about unmanageable divergence in both scope and membership. In non-disaster contexts, it has been observed that narrow parameters designed to minimize and so manage complexity can be persistent, often becoming particularly tenacious in the face of emerging environmental factors that have the potential to destabilize them (Van Meeker et al. 2013). This is far from a criticism of members, who were contributing to agency support tasks on a largely or completely voluntary basis, while under greatly increased work and time pressure due to engagement in other Canterbury earthquake sequence related projects. On the contrary, the wider evidence suggests that concerns of this kind are so common as to be a systemic effect. Narrow parameters, in other words, exert an influence that leads members of the relevant to defend them, irrespective of individual member traits.

The likely effect of these parameters on clients is more straightforward, and consistent with the requests that were in fact directed to the Advisory Group. Other than those concerning the Terms of Reference and recovery measures, all agency requests were for varieties of expert commentary or literature review. The consistency with the Terms of Reference leaves open the possibility that, once in place, this document may have influenced the kind of services requested from the Advisory Group. Agencies, in short, were likely to have understood from the Terms of Reference document that this was the type of service provided. It is notable that the four CERA requests made to the Advisory Group all fell into this category, and occurred over the period when this agency was actively engaged in developing several large collaborative research programs, including the Wellbeing Survey project, in collaboration with the NHRP. The last of these CERA requests concerned the possible inclusion of an established wellbeing scale in the Wellbeing Survey questionnaire. Directed to the Advisory Group Chair as a request for rapid commentary, this was distributed to members for input, and the consensus commentary returned to CERA five days later.

Material relating to this request was included in the Advisory Group archive as the group's last task. By contrast, earlier material forwarded through to the Advisory Group by members involved in support of the CERA Wellbeing Survey had all been archived as part of the task initiated, on April 5th 2011, on the basis of the original Ministry of Social Development request concerning reliable recovery measures. The categorization of this material thus reflects a degree of disconnect. The focus on the project – the development of indicators – appeared to have obscured the distinction between these as distinct projects, conducted by two different agencies. This, in turn, indicated a lack of integration between Advisory Group and NHRP activities as the year had progressed. A certain amount of distance had been necessary, due to the scope restriction that had required that the Advisory Group be established in the first place. As the recovery began to take shape, however, and the NHRP moved from supporting the response to supporting the recovery, this level of disconnect increased, to the point that it also appeared to have created a blurring around the nature and extent of the Advisory Group's role in NHRP activity. To some extent, this likely arose out of the ambiguity created by the fact that some were involved in both groups. It may also have been an effect of intense workloads and time-poverty. Efforts were made by those involved in both groups to ensure that Advisory Group members remained aware of NHRP activity – and were invited to contribute commentary where appropriate. The pace of activity and change, and volume of information involved, however, made this increasingly difficult. This difficulty was exacerbated by the Advisory Group's geographical location, and limited function and structure.

4.4.2.3 NHRP and Advisory Group integration issues

The Advisory Group's narrow membership, scope and structure were not the only limitations on its capacity to adapt to this rapidly changing environment. The nature and extent of parameter change required to facilitate their engagement in the developing recovery in Canterbury would also have required significant additional funding, and a more distributed geographical locus, including a base in Christchurch. This expansion of parameters across the scale, however, would have

replicated aspects of the much wider membership, structural, geographical and funding parameters that defined the NHRP social science theme. It was already mandated to allocate funding to collaborative social science research projects in support of agency recovery strategy and operations, and to drive integration with other disciplinary areas. As a national platform, the NHRP was better positioned geographically, with a membership that included Christchurch and Wellington organizations. Its broader and more flexible parameters were also better able to encompass collaborative activity with agency and other stakeholders in projects driven by agencies. This NHRP capacity enabled and was facilitated by the boundary spanning activities of the senior scientists involved in both the establishment and activities of the Advisory Group, and in other and subsequent NHRP activities in support of the response and recovery. Their roles in both bodies are thus broadly consistent with the growing body of work that finds that boundary spanning individuals who develop and maintain connections across domain boundaries can build trust, and improve coordination around decision making and implementation in governance networks concerned with complex public issues (Parker & Crona 2012, Van Meerkerk et al. 2013, Van Meerkerk & Edelenbos 2014).

In view of the above, integration of the Advisory Group into the NHRP might seem to have been a logical option. For two reasons, however, this was never really considered. Firstly, the scope issues associated with the overlap with health-related research remained, contributing, for example, to very similar NHRP and Health Research Council Canterbury earthquake sequence related research funding rounds in 2012 (Beaven et al. 2015). That such a narrowly focused group was required underlines the need to revisit the rationale for so strictly dividing the disaster-related domain into administrative and research areas according to the source of hazard. There would seem to be several valid grounds for a degree of relaxation around this stricture. Many of the psychosocial and other effects and consequences of disasters caused by natural, human and health hazards are similar. To divide them according to the source of the hazard would seem to run counter to what Helm (2009) identifies as the recent shift in New Zealand's larger strategic security focus away from the hazard source onto developing the

resilience of the wider source-community system. In the post-disaster context, moreover, the maintenance of this divide in the research domain would seem to be inconsistent with the provision for horizontal linkages at every level between the response agency hierarchy responsible for natural hazard risk management (aligned with the NHRP) and that responsible for managing and responding to health hazards (aligned with the HRC). These linkages have been put in place to facilitate response and recovery operations (McLean et al. 2012). It would seem appropriate to extend similar provisions for horizontal linkages between the research funding and coordination bodies linked with these agency groupings, at least in the post-disaster context.

A second and more immediate reason for not explicitly incorporating the Advisory Group into the NHRP was that, since demand for its services had tailed off, there was no urgent need to do so. Although termed a recovery advisory group, this initiative had been established as an adaptive measure to manage the spike in agency demand for psychosocial advice in the early phases of the response to the Christchurch Earthquake, and this had been managed effectively. Many Advisory Group members were increasingly involved in NHRP social science theme initiatives in support of recovery agencies in any case, including those whose boundary-spanning activities across the disaster-related science/policy interface had been instrumental in the initial establishment of this group. The core membership was drawn from an existing research network that remains active, as does the Center.

In any case, the parameters that had ensured the Advisory Group was well placed to respond to the early agency need for science support became restrictive as the recovery gained traction, largely because so many aspects of this need appeared undergo a reversal during this transition. In the early aftermath of this event, the time compression effect appeared so extreme that it had a limiting, even backward-looking effect, in that response agencies were forced to rely heavily on disaster-related knowledge, science/policy networks and specialist capacity that predated the relevant disaster event. As agencies moved into the recovery phase, however, the direction of this effect appeared to completely reverse, creating a

range of accelerated new forward-looking opportunities. The initial reliance on pre-existing networks, capacity knowledge and disasters rapidly gave way to a focus on new knowledge and evidence concerning this new disaster, the development of new recovery networks across science/policy and other domain boundaries, and building new disaster-related research, policy and other capacity.

Following the evolution of the Advisory Group against the backdrop of NHRP activities through this period of rapidly changing agency demand underlines the importance of adaptive capacity in the post-disaster environment. Immediately after the earthquake, agency demand for psychosocial recovery advice coupled with the NHRP scope restriction concerning health research emerged as an issue. This large organization's adaptive response was to rapidly establish a discrete parallel advisory body focused on managing this agency demand. Although this solved the immediate issue, it required the establishment of a narrowly focused body, restricted in both size and funding capability. The Advisory Group's purpose, the speed with which it was established and the need to ensure it did not replicate other ongoing NHRP activities all contributed to these restrictive initial parameters. As response transitioned rapidly into recovery, and agencies began to require research support to develop knowledge concerning this disaster event, the parameters created to address the earlier scope issue meant that this initiative was not a good fit with the science/policy interface emerging around the recovery.

The findings of this case study are thus broadly consistent with the wider body of literature that finds that narrow organizational parameters tend to have a limiting effect on the capacity to adapt in the face of new emerging issues (Verweij et al. 2014). The utility of this framework as an analytic tool lies in the way it turns the focus onto parameters that more usually operate in the background. The emphasis on the mediating effects of such parameters on the relevant organization's ability to engage with its environment helps to clarify the role these systemic, structural effects can and do play in the development of organizations. In this case, the narrowness of Advisory Group parameters effectively ensured from the outset that it would remain a short-term advisory initiative, due to the fact that it was specialized in relation to the needs of agencies during the

response.

The establishment of the group in such short order, on the other hand, exemplified the capacity of the much larger NHRP to respond adaptively to the onset of this major earthquake disaster, and the issue that emerged when agency demand exceeded one of its own organizational parameters. This analysis thus also points to the value of ensuring that large national arrangements are in place to manage the science/policy interface for decision-making in the disaster risk reduction area before the onset of disasters. Such events create an environment of accelerated change and increased complexity across domains, and particularly in those domains already engaged in this area. Designed and networked to manage research support across this interface and across the country, and with access to considerable research and funding capacity, this consortium was able and mandated to respond to this disaster largely because it was already in place.

4.5 Conclusions

It is likely that the agency demand for and reliance on pre-existing disaster-related knowledge, science/policy networks and specialist capacity identified after the Christchurch Earthquake happens after most disasters. The sudden onset of accelerated capital depletion and associated spike in time-compression have been found to be fundamentally characteristic of post-disaster environments (Olshansky et al. 2012). The demand for rapid timely advice has been found to be in tension, in any case, with time-consuming consensus-building activities, and so with those required in the development of new knowledge, policy, networks and specialist capacity (Sarkkie et al. 2014). It is thus logical on both counts that heavy reliance on pre-existing knowledge, networks and specialist expertise is necessary during the response period. The parallel progress of the Advisory Group and the NHRP through the transition from response to early recovery indicated that this reliance can reverse rapidly, as capital depletion gives way to the acceleration of capital replacement effected through and as disaster recovery. This is to suggest that time-dependent processes required for consensus building and lengthy data gathering and analysis are susceptible to the early post-disaster environment,

while escalating consensus-building is a crucial component in the suite of accelerated processes of institutional and capital replacement as the recovery gathers momentum, and that new recovery networks, knowledge, programs and capacity are part of the new social and institutional capital produced through those processes.

Three points follow. Firstly, the evolution of the Advisory Group indicates that arrangements that support the science/policy interface for response and recovery decision-making and implementation will rely heavily in the early response phase on disaster-related networks, knowledge and specialist capacity that predated the event. In the early aftermath, then, meeting agency demand for science support will be possible to the extent that such networks and specialist capacity are already in place. As response transitions into recovery, however, and the focus shifts more or less rapidly to the development of new knowledge from the new disaster, and of new disaster-related networks and capacity, it is the adaptive capacity of such arrangements that will dictate the extent to which they are able to meet agency science support requirements, and so maximize the range of accelerated opportunities for collaboration across the science/policy and other domain boundaries.

Secondly, the restrictive effects of narrow organizational parameters, which in other studies emerge over months and years of operation (Verweij et al. 2014, Edelenbos & Klijn 2006), appeared to be accelerated by the speed of change in this time-compressed post-disaster environment. The de-coupling of psychosocial recovery advice from the larger social science stream of work coordinated by the NHRP in support of response and recovery agencies, for example, was necessitated almost immediately after the disaster event by the effect of a scope limitation outside the larger organization's control. Similarly, the limiting effect of the Advisory Group's parameters began to be apparent only a month after establishment. This points to the need for unusually flexible parameters in organizations required to be active in response and recovery to disasters.

Finally, both the previous points underline the need for establishing organizations

to manage the science/policy boundary in support of disaster-related decision-making and action before disaster events occur. If the post-disaster environment is “just real life, in all its complexities, on fast-forward,” (p. 177, Olshansky et al. 2014), it follows that existing disaster risk reduction arrangements will be best placed to adapt to the increased complexity and rate of change that follow disasters. Equally, this case study underlines the importance of paying attention, when establishing such arrangements, to creating the inclusive, flexible organizational parameters that have been found to maximize adaptive capacity. The establishment of the Advisory Group after the Christchurch Earthquake was required by the scope that precluded the NHRP from involvement in health related research. It thus points to the need for a systematic cross-agency cross-sectoral approach to disaster risk reduction, focused in particular on increasing the flexibility of the parameters of all organizations required to be active after major hazard events, including those in the research domain. Aiming for the adaptive capacity required in the post-disaster environment will also pay dividends before disaster strikes, and when, after disasters, the complexities of life are no longer on fast forward.

The role of boundary organization after a disaster:
New Zealand's Natural Hazards Research Platform
after the 2010-2011 Canterbury Earthquake Sequence

5.1 Introduction

Where the Advisory Group was established to provide research support to agencies from inside the science domain, the much larger NHRP was positioned much further across the science/policy boundary. Required to bring senior research and policy representatives together to integrate medium to long-term research and funding, this consortium was also tasked with developing new, more collaborative networks between the organizations, disciplines and agencies already engaged in this arena. Decision-making goals included the allocation of government funding in order to progress the delivery of specific Intermediate Outcomes and so 'support the achievement of government endorsed strategies,' and also the development of research capability and networks to produce outputs of the 'highest scientific quality' (NHRP 2009A, 2009B).

For Guston, three criteria are definitive of boundary organizations: providing opportunities and incentives for the creation of boundary objects, such organizations involve participation from both scientific and policy domains, and are situated at the intersection of these domains, with 'distinct lines of accountability to each' (p. 401, Guston 2001). The boundary organisation concept was not used in the design or establishment of the NHRP. Since it meets all Guston's criteria to at least some extent, however, this consortium is open to analysis as a boundary organisation.

The analysis that follows has twin aims. It sets out to build a nuanced picture of the extent to which participation and accountability mechanisms situated the NHRP in relationship to research and policy goals domains. At the same time, it assesses the utility of the boundary organisation concept in the hazard and

disaster management context, focusing in particular on the use of such an organization after this disaster, and the impacts of the post-disaster environment on this boundary organisation. Within twelve months of the advent of the NHRP, New Zealand experienced the 2010-2011 Canterbury Earthquake Sequence, the largest natural disaster in seventy years. Barely established, the NHRP was required to coordinate the rapid collection and provision of a substantial body of hazard and disaster science to inform disaster response and recovery activities. It has been well established that major disasters significantly compress the time available for policy and other decision-making (Johnson & Mamula-Seadon 2014, Johnson & Olshansky 2013, Olshansky et al. 2012, Fordham 2007, Drabek 2007). The need for timely policy-relevant information has been found to be in fundamental tension with the consensus building required to achieve both scientific credibility, and legitimacy (Sarkki et al., 2014; Parker & Crona, 2012; Hackett, 1997; Fordham, 2007). Assessing the utility of the boundary organization concept in this context thus also provides insights into the NHRP's negotiation of this tension.

The chapter is largely based on secondary data. This includes a range of NHRP and other government documentation in the public domain, including the Ministry of Civil Defence and Emergency Management (MCDEM) review of the emergency response (McClean et al. 2012), and the Royal Commission of Enquiry into the Canterbury Earthquakes Report (Cooper, Carter, & Fenwick 2012), material from the National Crisis Management Center (NCMC) Log during the state of national emergency (22nd February – 30th April 2011), and the Ministry of Business, Innovation and Economics (MBIE) review of the NHRP (Buwalda et al. 2014), as well as scientific and grey literature (www.greylit.org) concerning the CES and its impacts, as available. The chapter also draws on observational and other data collected by the candidate and her supervisors. All were involved in aspects of the larger response operation to this event, with some (including the candidate) representing the NHRP on the science desk in the Christchurch Response Center during the state of national emergency.

5.2 Background

5.2:1 The boundary organization concept

The boundary organization concept is informed by complex systems theory, ecology, and related constructivist understandings of the distinction between science and non-science domains as a boundary between complex discursive systems (Jasanoff 1990, Guston 2001, Berkes 2009). Diverse disciplinary origins have also given rise to other closely related concepts, including 'science/policy interface' (Van den Hoven 2007, Sarkki et al. 2014), 'boundary management,' or 'systems for the translation of knowledge into action,' (Cash et al. 2003, Weichselgartner & Kaspersen 2012), and the umbrella term 'transdisciplinarity' for this family of concepts (Regeer & Bunders 2007). For the purposes of clarity this chapter uses the term boundary organization, since this term is often used in relation to science/policy collaboration arrangements. All share a focus on the boundaries between knowledge domains, and understand these boundaries to be in an ongoing state of development through the combination of social and historical circumstance and strategic behaviour described as boundary work (Guston 2001, Jasanoff 1990).

Since cross-over between domains is inevitable, is increasing, and carries significant opportunities and risks, evidence-based management of domain boundaries has the potential to increase opportunities, while also addressing the risks. Conceptualised as the agency that bridges the science/non-science boundary, the boundary organization in effect spans and incorporates the hybrid crossover boundary zone (Guston 2001, Drimie et al. 2014). Providing a forum that enables the co-production of socially robust knowledge by actors from different domains, such organizations usually involve specialised roles for managing the tension between domain drivers that arise around domain boundaries (Guston 2001, Regeer & Bunders 2009). Accountable to principals in both domains, boundary organizations aim to manage the instability characterising this interface by balancing domain drivers (Cash et al. 2003) and so functioning for the benefit of both, or all, domains (Guston 2001). Thus the rule driving the collaboration

across the boundary itself is the drive for legitimacy. Involving fairness and balance, legitimacy is enhanced by transparency, inclusiveness, and consideration of the values and interests of all stakeholders (Cash et al. 2003, Cash & Moser 2000, Clark & Majone 1985, Sarkki et al. 2014, Guston 2001).

Although balance remains an ideal goal, however, such organizations do not achieve stability, but rather enable a collaborative knowledge creation process that unfold unpredictably across tensions *within* the hybrid boundary zone. Boundary organizations must necessarily remain in a dynamic, fluid state, continually adapting to the divergent, changing and sometimes fundamentally incommensurate interests of a range of stakeholders who hold unequal and changing levels of decision-making influence (Parker & Crona, 2012). In addition to managing tensions across the boundary between larger science and policy domains, such organizations must also manage the effects of domain drivers around boundaries internal to the organization, as well as those which define it against the wider environment (Parker & Crona 2012, Verweij et al. 2014).

Parker and Crona's (2012) case study concerned a boundary organisation established to work closely with resource managers and policymakers to produce research and enhance long- term decision-making about water resources. They found that funding agencies, organizations and the academic community continued have greater influence over boundary organization decision-making than potential end-users in the policy community (Parker & Crona 2012). They also noted that despite strong pressure to do so, and continual focus on improvements in the area, this boundary organization made little progress when it came to interdisciplinary integration, again largely reflecting the influence of the academic community (Parker & Crona 2012).

5.2.2 The boundary organization concept: hazard and disaster management

Response and recovery structures and processes developed over the last twenty years to address the disruptive impact that disasters have in the policy and

decision-making domain can be seen as boundary management arrangements. They are designed to ensure that, after disasters, a range of relevant policy and cross-sector networks are activated and brought to bear on the accelerated decision-making required in the post-disaster environment (Drabek, 2007; Johnson & Mamula-Seddon 2014). The modular Coordinating Incident Management System (CIMS), for example, was introduced in New Zealand as a nested framework, feeding from local through regional or group level to the national level (MCDEM, 2009) (Figure 3, p 31 above). Providing the decision-making structure to be used after hazard events, CIMS brings a range of relevant agencies together with providers of lifelines, welfare and emergency services.

CIMS was introduced as part of a decentralizing, deliberative and integrated national approach to both managing and researching natural hazard and disaster risk (Johnson & Mamula-Seddon 2014, Helm 1996, 2009, Smith 2009). Devolving responsibility for risk to local and regional levels, with the goal of increasing both horizontal and vertical networking at (and between) those levels, this approach was and still is explicitly aimed at increasing the overall resilience of the larger complex system that includes both natural hazards and society (Helm 1996, 2009, Smith 2009).

5.2.3 The Natural Hazards Research Platform

The Natural Hazards Research Platform was established in 2009 – to further the same larger policy goal: ‘a New Zealand society that is more resilient to natural hazards’ (p.5, NHRP 2009B). The immediate catalyst for this initiative, however, was not recognition of the need for an equivalent organization to address the accelerated research decision-making and production required after disasters, but rather a 2007 international ranking of the New Zealand research environment as the most competitive in the OECD (Smith 2009). The NHRP was to be the first in a series of National Research Platforms in several areas of national significance, planned to counter the negative effects of this competitive climate by ensuring longer term research funding, and by fostering a less competitive, more stable, more collaborative research culture in these areas (NHRP 2009A).

At inception the NHRP included the six major research organizations responsible for the majority of nationally funded hazard and disaster research in 2009. The National Institute of Weather and Atmospheric Research (NIWA) and the NHRP host organization, Geological and Nuclear Sciences (GNS Science) are Crown-owned companies required to conduct scientific research for the benefit of New Zealand (Sections 4 and 5.1(a), CRI Act, 1992). What was new about the NHRP was that it brought these CRIs together not only with Opus, a private research consultancy, but also with three of New Zealand's eight universities, the Universities of Canterbury and Auckland and Massey University. Arbiters of academic quality, tertiary institutions are also responsible for building national research capacity through teaching and research programs.

In addition to integrating research activities across these organizations, the NHRP was also required to integrate relevant disciplines into five broad thematic areas. Risk evaluation models are a type of boundary object; the risk and resilience themes were to cut across and so integrate the three themes with a much longer traditional association with hazard and disaster management: geological hazards models, weather and flood prediction and resilient buildings and infrastructure (Figure 5, p 33 above). A Technical Advisory Group provided scientific peer review. The main mechanism for strategic integration across the science/policy boundary was the Strategic Advisory Group, which brought representatives of relevant agencies and other end-users together at least twice a year to provide support and guidance concerning strategic research funding decisions made by the NHRP. (Figure 4, p 32 above). Operational integration with agency end-users was to occur on a consultation basis, at both Management Group and Theme level.

5.2.3.1 Structure – demarcation of tasks and responsibilities

The NHRP governance structure was hierarchical, with host, anchor and funding organizations represented at the top through the Anchor CEO group (Figure 4, p 32 above).

Below this, the Platform Management Group was constituted of senior representatives of NHRP research organizations. Ultimate decision-making responsibility for the demarcation of broader research funding priorities rested with this management group, under the oversight of the Anchor CEO Group (NHRP 2009A, 2009B). Chaired by the Platform Manager (required to be an eminent scientist employed by the host CRI), the Platform Management Group did not include policy or other stakeholder representatives, although it did receive advice (at least twice a year) from the Strategic Advisory Group. Research theme leaders reported to, and were advised by the Platform Management Group. A Technical Advisory Group comprising international science and technical expertise contributed to scientific quality control at both Management Group and Theme Leader level. Individual contestable research programs were externally peer reviewed, and sub-contracts devolved responsibility for the detail of such programs to relevant lead research organization(s) (NHRP 2009B).

The NHRP's decision-making structure thus indicated that at the outset, research organizations and research funders had more power to influence decision-making than policy and end-users, concerning both broader strategic research funding priorities, and individual research programs. Within this more powerful research bloc, moreover, the CRI host organization had more influence than other member organizations.

5.2.3.2 Function – substantive scope

This structural effect contrasts, however, with the emphasis in the six principles provided in the NHRP interim strategy to guide decision-making (NHRP 2009A). When mapped onto the spectrum of boundary tensions, these decision-making goals cluster at the policy end of this continuum (Figure 15). Four of the six specified NHRP principles sit at the policy end of this spectrum, reflecting a government emphasis on a more active, strategic approach to management and research in this area of national interest, in order to increase evidence-based policy. These principles indicated that end-users should be engaged not only in

deciding broad research direction, but also wherever possible, in all stages of the research process (including decision-making). This is consistent with the high level recognition of the need to strategically manage collaboration across the science/policy boundary in the national interest that led to the establishment of the NHRP. Even those principles requiring the NHRP to work with end-users to provide policy-relevant outcomes, however, are solely concerned with the production of research. Founding documents do not include balancing provisions for NHRP involvement in policy formation (at any level).

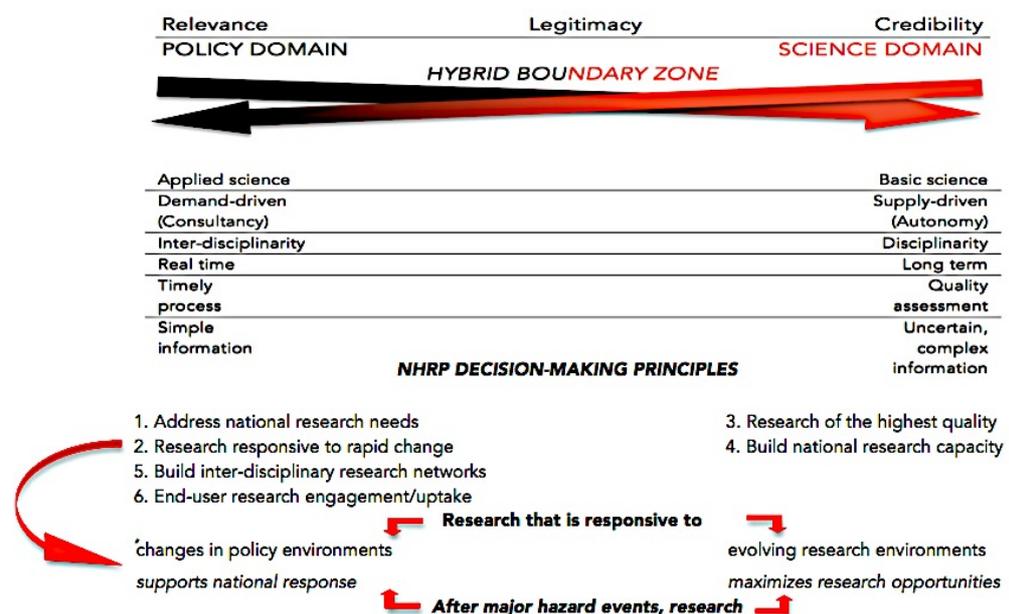


Figure 15: NHRP research principles aligned with the spectrum of boundary tensions (adapted from Sarkie et al. 2014 and Parker and Crona 2012)

Contractual arrangements similarly reflect the predominance of research domain drivers. The NHRP partnership agreement is signed by the research funding agency and research organizations (all situated in the research domain), and focused on managing research outputs and tensions between research organizations (NHRP 2009B). Similarly the multi-party Foundation Contract specifies contractual obligations between NHRP host and anchor organizations and the funding agency, while funding for research programs was sub-contracted to member organizations by the NHRP (NHRP 2009A). At each contractual level,

all contractual partners were based in the research domain, and contractual obligations concerned research quality and productivity (measured in relation to peer reviewed publications).

Thus although required, by its decision-making principles, to focus on the co-production of policy-relevant research with representatives from the policy domain, at inception the structure and function of this new boundary organization dictated that the NHRP remained almost entirely driven by research domain drivers, leaving it awkwardly situated across the tension spectrum characterizing the science/policy boundary.

5.2.3.3 Disaster response

This larger tension between domain drivers is reproduced at more detailed levels. The principle requiring the NHRP to provide research advice and support to government after major hazard events, for example, as a short-term rapid research response principle is situated at the applied end of the tension spectrum. When considered in detail, however, it also maps across the larger spectrum. Specifying that research should be responsive to rapid changes in both policy and research environments, it requires research support for government response efforts, and also that the NHRP maximises the research opportunities created by hazard events (Figure 15).

The policy/science tensions arising around the responsive research principle can be related to the differing roles of member organizations. As CRIs, NIWA and GNS Science had existing responsibility for providing science advice to policy makers, and after major hazard events. As arbiters of research quality, universities are necessarily engaged with changes arising out of evolving research environments, and are also responsible for maximising research opportunities wherever possible. Prior to the NHRP, there had been few formal mechanisms to coordinate science/research information/service provision into national, regional or local CDEM frameworks. Arrangements tended to be hazard and or region specific (as in regional volcano advisory groups, and regional and national tsunami

advisory groups).

The potential advantage of the NHRP arrangement was that for the first time it created an official avenue for widespread research collaboration in support of emergency response and recovery operations, which included academic and private organizations as well as CRIs. Linked back into organizational, disciplinary and international research networks, as well as connected into agencies, this new structure provided a mechanism to bring the resources of these networks to bear on the accelerated decision-making and research activity required after disasters. At the same time, it also opened the way for mobilising widespread, coordinated hazard and disaster research in order to address the research opportunities created by disasters, as discussed in Chapter 3 above.

The potential advantages offered by the newly established NHRP were put to the test almost immediately, when coordination of research activity during and after the 2010-2011 Canterbury Earthquake Sequence fell within the remit of this boundary organization.

5.2.5 Science response to the Canterbury Earthquake Sequence

On 4 September 2010 the M_w 7.1 Darfield earthquake occurred, 10 km deep and ~35km west of Christchurch, New Zealand's second largest city (pop. 390,300 as at June 2010 <http://www.stats.govt.nz/>). This was the first in a sixteen-month sequence of earthquakes that trended eastwards across Christchurch, punctuated by a further three large earthquake events which caused significant additional damage (Bradley et al. 2014)

The NHRP was mandated to coordinate the science response to the Canterbury Earthquake Sequence, and also required by the responsive research principle to support the government response effort and to maximize research opportunities. Barely established, however, it had had little time to build its profile and develop networks, and founding documents lacked detailed guidance or protocols. As a result the NHRP coordination effort over this period developed organically,

adapting in response to developments in the wider environment, including agency demand. After the initial Darfield Earthquake local Christchurch scientists self-activated within hours, conducting assessments and gathering fault, seismic, liquefaction, building and infrastructure data across the city and surrounds. Within days, this activity had developed into the series of broadly themed research operations that was to characterize the ongoing collaborative research effort coordinated by the NHRP throughout the Canterbury earthquake sequence (Table 5, Appendix 2).

While much NHRP-funded research activity into the earthquakes continued to take advantage of opportunities for basic research (eg Quigley et al. 2012), the overwhelming emphasis was on supporting the needs of responding agencies, and impacted communities. After the Darfield earthquake, research activity was loosely coordinated out of the regional emergency coordination center at Environment Canterbury (ECAN), through daily NHRP briefing sessions attended by representatives from member organizations, key research operations, response agencies and others. Raising awareness across the wider research effort, these daily sessions provided a crucial channel of communication, both within the post-disaster research collaboration and with responding agencies. After the Christchurch earthquake, this first informal base in the response coordination center was formalized in on-site Christchurch Response Center, which for the first time included a science function arm in the planning branch of the CIMS structure. Although this new position improved face-to-face communication with response operations and research programs being coordinated out of this center, this improvement was at the expense of daily NHRP briefing sessions, which were not conducted out of the CRC, largely due to the greater scale of the response.

The NHRP was also involved in facilitating research projects out of the Christchurch Response Center that included a range of sophisticated boundary objects. Lidar and liquefaction GIS databases, for example, brought together a range of detailed data concerning land movement and liquefaction following the earthquakes. Interactively produced, and ultimately informing land-zoning and other planning decisions, these boundary objects also facilitated the interactive

production of a range of maps and other accessible representations translating research findings into outcomes benefitting both agency end-users and researchers throughout response and recovery operations (Table 5, Appendix 2). A range of public meetings, workshops and seminars, including an ongoing NHRP seminar series, provided more opportunities for the translation of both existing scientific knowledge and new research findings concerning the Canterbury Earthquake Sequence into accessible terms, and for audience interaction. These were attended by local and national policy and decision-makers, by practitioners and members of impacted local communities, as well as researchers wishing to come up to speed with the current state of knowledge at the time. Accessible to a greater or lesser degree from both sides of the science/policy boundary, these boundary objects helped both in the translation of science data and knowledge into accessible terms, while also facilitating the communication of policy and community needs.

The reach of the NHRP's coordinating influence was extended by its responsibility for funding a wider range of earthquake-related research. Existing NHRP funding for this purpose was boosted after the Darfield earthquake by an additional NZ\$1 million of government research funding (Berryman 2012). A further NZ\$3 million per year, for four years, was provided after the Christchurch earthquake to address Canterbury Earthquake Sequence impacts and identify lessons that could be applied to other centers (Berryman 2012, Buwalda et al. 2014). The continued focus on agency engagement was evident in calls for short and medium term earthquake-related research proposals, which made funding conditional on evidence of endorsement of the relevant proposal by an agency or organization involved in response or recovery operations. This applied to retrospective funding applications for research conducted immediately after the major events, as well as those proposing new projects. By requiring researchers to engage with agencies and organizations involved in the response, this requirement also brought current and potential research activity to the attention of these agencies, further opening the possibility of cross-sector collaboration at this operational level.

5.3 Discussion

Despite initial constraints, it is clear that this large consortium of research organizations and agencies was able to bring a new level of research networking capacity to bear on collaborative decision-making with response and recovery operations. Review documents confirm the NHRP played a major role in the production of a coordinated range of earthquake-related scientific outputs of high quality (McLean et al. 2012, Buwalda et al. 2014), many of which fed directly into policy and practice decisions (Table 5: Appendix 3). The inclusion of a new science liaison function in the Christchurch Response Center, and the more recent provision in the new, draft CDEM plan for the NHRP to coordinate emergency research support after future events (MCDEM 2014) also testify to the unprecedented levels of collaboration with response agencies achieved during and after these earthquakes. As a pilot, then, the NHRP demonstrated that it is possible to use a boundary organization to bring a large section of the hazard and disaster research community into collaboration with the response operation (Buwalda et al. 2014). To this extent it functioned as the research equivalent of response and recovery structures (such as CIMS and CERA), which also bring the resources of multiple agencies into post-disaster decision-making and activities (Drabek 2007, Johnston & Mamula-Seddon 2014). As well, this research effort established that such boundary organizations have the potential to coordinate research activity after major disaster events in such a way as to convert the urgency created by the hazard event to increase the uptake of research opportunities, including the opportunity to engage end-users, and the provision of scientific evidence as the basis of decision-making (Buwalda et al. 2014).

Findings from other disaster events indicate that demand for rapid research provision can require trade-offs in relation to research quality assessment and verification processes, meaning that rapid research provision of this kind can occur at the expense of scientific credibility (Sarkki et al. 2014, Parker & Crona 2012, Hackett 1997, Birkland 2009, Black 2003). There is evidence, however, that rather than compromising quality and productivity, the pressure to respond to this

earthquake disaster had a positive effect in relation to both Canterbury Earthquake Sequence related research, and the larger NHRP research effort (Buwalda et al. 2014, McLean et al. 2012). All contracted annual quality and productivity standards were met or exceeded over the first four years of NHRP operation, and the introduction of this organization was found to have resulted in a significant improvement in overall national hazard and disaster research quality and productivity over this period (Buwalda et al. 2014). Like the existence of contractual research quality standards, this performance is consistent with the strong research grounding and focus of the NHRP, its component research organizations, and the funding agency.

There is no doubt that the pressure to respond to the Canterbury Earthquake Sequence resulted in increased operational integration between disciplines and organizations, as well as with end-users. This represented a significant re-balancing of NHRP focus and activity at the operational level, as it produced research of high quality that was also relevant to the needs of operational agencies. But there is also some evidence that the NHRP's strong grounding in the research sector left it exposed to the effects of the trade-off, identified by Sarkki et al. (2014), between the demand for rapid research provision and the consensus building required to establish the legitimacy of cross-boundary collaborations, and that this may have been at the expense of integration at several levels.

5.3.1 Legitimacy & organizational integration

In the post-disaster environment, the NHRP provided for the first time a national integrating mechanism capable of drawing on a range of academic, CRI and private research organizations, and reaching back into organizational, disciplinary and international research networks, in order to bring the considerable resources of these networks to bear on the accelerated decision-making and research activity required after disasters. But while the effectiveness of this mechanism can be discerned in the quality and range of CES-related research activity, the number of organizations involved, and the uptake of research findings in policy and

decision-making, this integration effort remained largely behind the scenes.

This was due in part to the lack of provision in founding documents for the specific distribution of responsibilities and demarcation of tasks between organizations after hazard events. There were also no strategies, protocols or processes for managing the implicit tensions between organizations, and between their traditional spheres of responsibility. In the absence of formalised guidance, those involved in both the NHRP and the response operation shared the assumption that the NHRP director, who was also the chair of the NHRP Management Group, would lead and be the “face” of the effort coordinated through decision-making by the Management Group, theme leaders and others involved in this collaboration. The NHRP director’s authority as an eminent scientist, and considerable experience providing earthquake advice on behalf of GNS before the advent of the NHRP further qualified him for this role.

As the Canterbury Earthquake Sequence unfolded, however, this experience, and the fact that this director continued to be based inside GNS science appeared to aggravate the effect of the structural crossover between the new NHRP role and the traditional, and so more familiar advisory and support responsibilities of its host organization (discussed in Chapter 3 above). After the Christchurch earthquake, the NHRP director and other GNS staff relocated into the Christchurch Response Center, to facilitate a clear conduit for seismology and land damage information, and engage with the other research programs being run out of this Emergency Operations Center. This made it more difficult for some of the programs that were not being run out of the Christchurch Response Center to engage with the NHRP operation. At the same time, assumptions as to the demarcation of tasks and responsibilities between the CRI and the larger consortium defaulted increasingly to GNS Science (Buwalda et al. 2014). Researchers representing the NHRP at the Science Liason desk were understood to be working for GNS Science on the GNS Science desk. Subsequent higher level official review documents, including the MCDEM review and the Royal Commission of Enquiry, referred to GNS Science only in relation to science and research coordination in the CRC (e.g. Cooper et al. 2012, Mclean et al. 2012,

OAG 2012).

Almost completely invisible in this official sphere, the larger NHRP coordination effort appeared to have been eclipsed by the traditional role of its host organization. This was not the case in fact – the NHRP retained official responsibility for the science coordination effort, during this period, and decisions made by the Management Group resulted in the extensive involvement of member organizations and their networks in both NHRP decision-making, and the range of research programs that made up this effort. The lack of visibility, however, created the perception of a major imbalance between platform organizations, leaving the NHRP exposed to the perception that its funding and operational research activities were being conducted during this period by, and for the benefit of, a single member organization. It has been well established that the perception that the interests of one group have been privileged at the expense of others risks bringing the legitimacy of the relevant collaborative activity into question, so putting the larger collaborative enterprise at risk (Cash et al. 2003, McNie 2007, Parker & Crona 2012). Thus the invisibility of the NHRP after the Canterbury Earthquake Sequence inhibited its ability to integrate both member organizations, and recruit new partners, working against gains in organizational integration created by the urgency of this event.

The reversion of the NHRP 'brand' to that of member organizations has been identified as an issue that continues to inhibit this boundary organization's ability to build relationships with end-users, as well as stakeholders (Buwalda et al. 2014), suggesting that this post-disaster effect continued to have a major impact on the overall development of NHRP management and strategy.

5.3.2 Legitimacy and thematic (disciplinary) integration

The 2014 review of the NHRP noted limited progress in the area of disciplinary or thematic integration (Buwalda et al. 2014), which is related to NHRP's difficulty integrating partner organizations. At inception, the NHRP research focus was structured into broad themes, in an attempt to bring organizations and disciplines

together within themes, so fostering integration (Figure 4, p 32). Loosely corresponding with larger disciplinary formations, the three larger more traditional themes were also broadly aligned with the interests of member organizations. Geological perils was led by GNS, weather related perils by NIWA, and the resilient buildings and infrastructure program was largely driven through engineering programs at Canterbury and Auckland Universities (Buwalda et al. 2014).

The sub-contractual funding of major thematic research programs to individual organizations reinforced the tendency of these first three themes to continue to evolve in parallel. Risk and societal resilience were subsequently added as crosscutting themes. In the absence of formal integrating mechanisms, and due to the sub-contractual approach to awarding research funding, however, there were few opportunities for these themes (led by GNS) to function in a crosscutting, integrating capacity. Evidence from environmental management and climate change research organizations indicates that formalized disciplinary integration mechanisms, including universal incentive and accountability regimes, are more likely to create stable inter-disciplinary practices and cultures than informal mechanisms and charismatic leadership (Lengwiler 2006).

The lack of formal integration mechanisms in the NHRP meant that the research response loosely coordinated by the NHRP after the Darfield earthquake rapidly evolved into the parallel geological, socio-economic and engineering research programs included in the new science arm of the Christchurch Response Center structure (McLean et al. 2012) While the development of these programs was organic, this thematic structure was consistent with that of the NHRP. And although the majority of this research activity was funded through the NHRP, who also provided science advice to agencies within the Christchurch Response Center, the coordination of these programs fell into three distinct and largely discrete research streams, coordinated by and through relevant member organizations. Only the geological and socio-economic research programs were operationally coordinated out of the Christchurch Response Center by NHRP theme leaders; both were also GNS scientists. Structural engineering assessment

and data collecting programs were run as a parallel but entirely stand alone operation (McLean et al. 2012), coordinated by engineers from the Universities of Auckland and Canterbury in collaboration with the Department of Building and housing (NCCM Log 2011). Scientists from the regional and city council response operations (respectively) were jointly responsible for coordinating the wider geotechnical research program in collaboration with member organizations and other private research providers. This included investigations of rock-fall and slope stability, as well as liquefaction and related ground and foundation damage. Although employed by responding agencies, rather than NHRP member organizations, these scientists were also based at the science desk in the Christchurch Response Center.

The response operation was similarly structured into discrete agencies with distinct responsibilities for building and housing, infrastructure and lifelines, land planning, and social services. Mapping onto this response operation, the streamed research effort thus reflected not only the NHRP thematic structure, but also the salience of demand-driven research and information created by the post-disaster environment.

Individual time constraints have been found to be a significant barrier to inter-disciplinarity, as well as other types of integration, during business as usual conditions (Bruneel et al. 2010, Parker & Crona 2012, Sarkki et al. 2014). In the absence of formal integration mechanisms, under increased time pressure, and in response to urgent agency demand, the NHRP consortium structure appeared to have fallen back on the resources of member organizations, and so decoupled into discrete and largely mono-thematic organizational operations. The impact of the Canterbury Earthquake Sequence on the NHRP at this early and formative stage in its development is thus likely to have been a significant factor in what Buwalda et al. (2014) identify as the consortium's continuing struggle to increase thematic integration.

5.3.3 Legitimacy & higher-level integration

Although meeting or exceeding research quality and productivity standards during its first four years of operation, the NHRP continued to manifest a largely operational focus on providing research in response to agency demand (Buwalda et al. 2014). Buwalda et al. (2014) found that this focus worked at the expense of higher-level strategic integration, and was also hazard-centric, inhibiting the development of a research strategy focused on the resilient outcomes required by the Crown policy strategy (Buwalda et al. 2014). From a boundary management perspective, these findings are consistent with the structural imbalance that positioned this organization largely in the research domain, and the disaster effect that aggravated rather than ameliorated the effects of that imbalance.

At inception, the NHRP was charged with strategically managing the national hazard and disaster research investment in conjunction with the agencies and other end-users, but lacked effective structural and functional mechanisms to achieve this task. Founding documents also limited the scope of NHRP activities to the research sphere, making no reference to or provision for NHRP involvement in the co-production of policy strategy. Almost immediately the impact of the earthquake disaster catalyzed an overwhelming operational focus, driving the collaborative operational decision-making with response and recovery agencies evidenced in the range of scientific outputs that fed into earthquake-related policy and other decision-making (Table 1), and the first time inclusions of science as a function in the CIMS structure, and of the NHRP in more recent CDEM response plans (CDEM draft plan 2014).

The main incentive and accountability mechanism driving NHRP activity during this four-year period allowed it to maintain high quality levels, despite this operational focus, but lacked a balancing emphasis on the co-production of research and policy strategies focused on resilient outcomes. Resilient research outcomes are determined by the extent to which research activities and outputs are relevant to the goal of Crown policy strategy: a New Zealand society that is more resilient to natural hazards. By contrast, a hazards focus aligns with distinct

research disciplines: geological hazards (volcanoes, earthquakes, landslides, rockfalls), climatological and coastal hazards (cyclones, tornadoes, excessive snowfalls, tsunami), and the hazard-centric engineering branches (earthquake engineering, fire engineering, hydrological engineering, geotechnical engineering). In effect NHRP contractual requirements prioritized research quality over thematic integration. Research productivity and quality standards were measured with reference to disciplinary peer review quality assessment processes, and the quantity and impact status of peer reviewed publications (Buwalda et al. 2014). Rather than simply reflecting an oversight, on the part of NHRP leadership or management, the tenacity of this boundary organization's thematic structure was strongly reinforced by contractual obligations, which thereby worked against the development of a research strategy focused on resilient outcomes.

There is evidence that the post-disaster environment may have cemented these constraints, further inhibiting this boundary organization's ability to develop higher-level strategic alliances in the policy sector. The increased relevance of hazard and disaster research created by the earthquake disaster led to a number of calls for Canterbury Earthquake Sequence-related research proposals in 2012 funding rounds. These included calls for proposals from agencies with no prior record of funding research in this area, such as the Health Research Council. The NHRP interim strategy document tasked the consortium with contributing to the coordination of hazard and disaster research funding across government agencies (NHRP 2009B). Thus the 2012 funding round represented an opportunity for the NHRP to coordinate research funding across government agencies, as per its mandate, and thereby engage with new potential end-user agencies at the strategic level. Coordination across agencies on this occasion could also have increased integration at both disciplinary organizational levels, by bringing a new range of researchers and agencies together, and so consolidating larger collaborative research programs.

Although the NHRP director was well-networked at high levels within agencies with a history of involvement in hazard and disaster management, the NHRP lacked explicit formal mechanisms for this kind of high-level coordination activity

with other funding agencies. There were also no mechanisms for encouraging other agencies to consult with the NHRP when funding disaster-related research policy engagement. This, together with the narrowing of NHRP focus onto operational engagement with end-users, the invisibility of the NHRP brand and the involvement of funding agencies not previously involved in the hazard and disaster management arena appeared to contribute to a breakdown of communication at this higher level between agencies and the NHRP concerning 2012 Canterbury Earthquake Sequence research funding initiatives. Several non-NHRP funding rounds calling for Canterbury Earthquake Sequence-related research proposals occurred and were awarded without consultation with the NHRP. In the social science area, this led to a number of new, more or less parallel funded projects focused on Community Resilience, alongside an existing longer term NHRP community resilience research program.

The restructuring of the NHRP's parent funding agency was also a factor here. At the time of these Canterbury Earthquake Sequence-related 2012 research funding rounds, the NHRP's original contractual partner, the Foundation for Research Science and Technology, had been restructured twice. This foundation's policy and investment functions had been taken over by the newly created Ministry of Science and Innovation three weeks before the Christchurch earthquake, on 1 February 2011 (www.msi.govt.nz). Eighteen months later, in July 2012, further restructuring included the transfer of Ministry of Science and Innovation's policy and investment functions to the larger Ministry of Business, Innovation and Employment (www.mbie.govt.nz). The Ministry of Business, Innovation and Employment was one of the agencies that issued a call for Canterbury Earthquake Sequence related social science research proposals, and subsequently awarded them, without consultation with the NHRP. Loss of institutional knowledge and key points of NHRP contact within the agency, and the enormous challenges of the Canterbury Earthquake Sequence may have contributed to what appear to have been a breakdown of communication, indicating that the NHRP had not been able to maintain strong connections with all departments within this newly created parent agency.

Again, this is to suggest that the effects of the time-compressed post-disaster environment on the NHRP may have aggravated pre-existing structural limitations on its capacity to network at higher strategic levels. This capacity would have been greater if, rather than being set up as a Natural Hazards Research Platform, this organization had been designed as a Natural Hazards Platform, with equivalent emphasis on – and engagement with – both research and policy sectors.

5.4 Conclusions

The boundary organization concept provides a schematic template that makes it possible to build a nuanced picture of the way domain driver interactions combined with the effects of the Canterbury Earthquake Sequence to shape the development of the NHRP over its first four years. This closing section draws from this picture to illustrate three broad aspects of the utility of this concept that arise from its grounding in complexity theory, before ending with some concluding comments about anticipating the influence of disasters on research/policy collaborations when designing boundary organizations in this area.

The first aspect of this concept that makes it useful in the hazard and disaster context is the continuing emphasis on the importance of *balance*. Driving collaboration between domains, the goal of legitimacy is enhanced by balance between research and policy domains; more balanced participation, functional and structural elements contribute to more balance in the influence of the rules that govern activity within each domain. Perfect balance is of course not achievable – legitimacy is an ideal, like credibility and relevance. Retaining a focus on aiming for this balance helps to clarify the imbalances that can inhibit cross-boundary collaborations. When NHRP scope (function) and the demarcation of tasks and responsibilities (structure) were mapped over cross-boundary tensions between domain drivers, for example, neither function nor scope were balanced in relation to domain drivers, being instead counter-weighted. Decision-making principles and stand-alone references in contract and strategy documents emphasized the co-production – with agency end-users – of research strategy and activity that delivered policy-relevant outcomes (NHRP 2009A). This emphasis was

undermined by the structural emphasis on scientific credibility apparent in the design of contractual and participation arrangements, and decision-making roles and responsibilities. Effectively dictating the focus and operating parameters of this organization, these structural elements ensured that the NHRP focus remained restricted to producing high quality research, maintaining research capacity, and managing a collaboration between research providers and a research-funding agency. This strong grounding in the research sector is required of a successful boundary organization. The NHRP, however, lacked the balancing grounding in the policy sector required to ensure that collaborative processes and outcomes are as relevant as they are scientifically credible.

As a design tool, then, this concept is useful because it requires that awareness of domain drivers informs decisions defining the parameters of the boundary organization, with a view to achieving and maintaining that larger balance between research and policy domains. To make it possible for an organization like the NHRP to effect the co-production of research strategy and outcomes focused on both scientific quality and policy-relevant outcomes, decisions concerning changes to participation, function and structure would need to be made to achieve this balance. Equally, this points to another boundary organization concept requirement – such decisions also need to be internally consistent, or balanced, so that organizational parameters are mutually reinforcing with respect to this larger balance. In the case of the NHRP, moves toward this balance would have required increased engagement from the policy domain in every area.

This leads to the second point, concerning the *breadth of perspective* enabled by the boundary organization concept. The emphasis on balancing domain drivers and interests requires that the relevant collaborative arrangement is assessed in relation to these wider domains, and so in relation to wider social, political and cultural contexts. When used to assess the NHRP, this concept extended the focus of the assessment to include dimensions of the policy domain currently outside this boundary organization's parameters. Requiring that NHRP performance was measured in relation to research quality and productivity as assessed in the research domain, research funding agency engagement in this boundary

organization largely reinforced the dominance of this research domain driver. This emphasis on domain drivers thus clarified the extent to which the NHRP remained focused on, positioned and driven from within the research domain, and so brings the missing range of engagement from the policy domain squarely into frame. Re-balancing the position and focus of this boundary organization would need to be driven from high levels in the policy sector, require a distinct line of accountability to that sector, and would require engagement from a range of end-user agencies, at all operational and strategic levels, and at all stages of development. This thus also points to the need to ensure equivalent input from research and (end-user) policy domains at the design stage of new boundary organization initiatives in this topic area. Requiring that as much work is done within the policy domain as occurs in the research domain at this design stage would also have the advantage of bringing research and policy representatives together to collaboratively develop participation, functional and structural parameters, in this way beginning the ongoing collaboration to be effected by the boundary organization.

Thirdly, the boundary organization framework is useful because it is capable of analyzing the effects of domain drivers at a range of different levels, because such complex system effects (Song et al. 2005) create self-similar patterns at smaller and larger scales. This affords a multi-layered perspective that others have applied simultaneously at local, national or global level for example (Djalante 2012, Cash et al. 2000). At the same time it allows the contracted focus (as in this thesis) required for the assessment or design of detailed interactions between organizations, or within a single organisation, between themes or within them, and so on. The rule requiring that those in the research domain strive for research quality, for example, applies at all levels within this domain, although the detail of the way it is defined and understood can vary greatly between the social and physical sciences, between organizations, from one discipline to the next, and between researchers in the same discipline. Since this is also the case with the rule requiring that those in the policy domain strive for relevance, the fundamental tension between these drivers influences all levels of interaction across boundaries (Sarkki et al. 2014, Van den Hoven 2006, 2007, Cash et al. 2003). This scale-free quality made it possible to trace the tensions manifest in the NHRP's initial

parameters at disciplinary, thematic and organizational levels, as well as across the boundary between research and policy domains. Facilitating a layered perspective of NHRP integration initiatives, this applicability across levels also clarified interdependencies between levels. The NHRP was tasked with integrating organizations and disciplines, but a lack of formal mechanisms to effect this task was exacerbated by a loose correspondence between thematic areas and organizational specialisations. Similarly, funding contracts between the NHRP and member organizations concerning specific research programs did not specify, require or incentivize integration, and there was no structural provision for integrated NHRP decision-making in this area (since theme leaders were responsible for research programs). This structural resistance to integration was further compounded, at the higher level, by a funding agency focus on contractual performance standards concerned with research quality and productivity, measured according to assessment criteria dominated by mono-disciplinary journals and review processes, rather than on performance standards concerned with integration. As each level is manifestly driven by concern for research quality, the cumulative effect is at the expense of the integration required for the production of socially robust knowledge that is politically relevant as well as scientifically credible. The application of this concept across scales makes it useful when designing or modifying science/policy collaborations. It underlines the need for robust organizational and methodological mechanisms to facilitate integration at all levels, again with a view to not only increasing integration, but to ensure that integration efforts remain as balanced as possible. Requiring and incentivizing integrated decision-making and methodological agreement within and between themes and organizations, and ensuring that accountability is equally distributed has been linked in related topic domains to stable, stringent forms of inter-disciplinarity (Lengwiler 2006).

Finally, the boundary organization concept is useful when it comes to the effects of disasters on science/policy collaborations in this space. It serves as a useful counterweight to the blame attribution common after high profile disasters (Birkland 1998, Paton 2014). Destructive of resilience at both individual and community levels (Mooney et al. 2011), blame attribution can prevent evidence-

based disaster risk reduction policy by forestalling rigorous investigation of the systemic factors that contributed to the relevant disaster (Birkland 2009). The boundary organization concept is focused on effects, patterns and trends, rather than individual or organizational performance, and has explanatory force concerning the urgency and time-compression that drives blame attribution, and other monocausal disaster explanations (Birkland 2009). Increasing the power of response agencies to influence research and policy decision-making, this urgency fuelled the intensity and range of operational research collaboration with agencies coordinated by the NHRP in response to the Canterbury Earthquake Sequence. Channeling the resources of the wider consortium to generate research activity and outputs that were of high quality *and* were relevant to the operational needs of response and recovery agencies, the NHRP indicated that boundary organizations can be used to integrate national research capacity to provide the accelerated decision-making and support required by agencies after major hazard events. The development of the NHRP over this period also confirmed that this strong operational performance was not at the expense of research quality, in either Canterbury Earthquake Sequence-related or overall NHRP outputs, since all research quality and productivity standards were met or exceeded over this period. There were indications, however, that the operational integration achieved in response to the Canterbury Earthquake Sequence came at the expense of integration at thematic, organizational and sector level. Although time-pressure is part of the drive for relevance dominant in the policy domain, the time-compression created by this disaster appeared to aggravate the drag of research domain drivers on the NHRP. This effect is consistent with the pre-existing weighting of this organization towards the research domain. Corresponding to a drift away from integration across organizational and thematic boundaries during this period, the aggravation of this pre-existing weighting is consistent with the trade-off between post-disaster time-compression and the consensus building required to develop integration across disciplinary and sector domain boundaries.

Boundary organizations in this topic area are likely to be required to respond to major hazard events. Three points can be made concerning the design of such boundary organizations. Firstly, a longer run up before the advent of a major

hazard event would have given the NHRP more time for the consensus-building required to establish robust, integrated networks between organizations and with agency end-users. More established networks would have been likely to increase the ability to withstand the negative impact of time-compression on integrating activities across domain boundaries, in part through increasing the collective resources brought to bear on post-disaster research coordination. Thus pre-existing boundary organizations, with established integrative networks, are likely to be best placed to coordinate research after major hazard events, and in the process to minimize negative impacts on both research quality, and integration across disciplinary, organizational and sector boundaries.

Secondly, the design of boundary organizations set up to integrate research and policy in the hazard and disaster risk reduction area should anticipate the effects of disasters on organizational structure and operation, and include mechanisms to actively manage these effects after disasters. The NHRP's ability to maintain research quality and productivity despite this pressure indicated that high level accountability and contractual requirements in the research domain can mitigate the effect of disasters on research quality. This success contrasts, however, with the susceptibility of this organization to the impact of time compression on integrating activity across all domain boundaries, and the associated difficulty producing research strategy and outcomes focused on achieving resilience. Emphasising the need for a wider range of formalized incentive and accountability measures in general, this contrast draws attention to the lack of equivalent contractual and accountability measures requiring that this organization achieve the integration and focus required by policy domain drivers. Including such measures – at all levels – when designing boundary organizations in this area would significantly improve capacity to resist the effects of post-disaster time-compression on integration.

Thirdly, however, it is clear that the incentive and accountability measures that helped mitigate the effect of time-compression on the quality of the research produced by the NHRP were successful because this organization was strongly grounded in the research domain. It follows that equivalent measures designed to

mitigate this effect on the integration and relevance required by policy drivers will be successful to the extent that boundary organizations in this space are equally strongly grounded in the policy domain. Since the time-compressed environment aggravated pre-existing imbalances in NHRP structure and operation, it is likely that designs that effectively balance the influence of policy and research sectors should increase the resilience of the relevant organization to the risks thrown up in the post-disaster environment.

This chapter, like the NHRP itself, is largely concerned with integration within the research domain, and between research and policy sectors. There is considerable scope for future research applying this concept in the hazard and disaster area, to policy sector engagement in boundary organizations, to the assessment, design and implementation of boundary organizations involving multiple stakeholder domains (including business and NGO sectors, and local communities), and when comparing similar boundary organizations from different global regions. Finally, given the extensive application of this concept in the global sustainability and climate change contexts, its application in the disaster risk reduction context also opens the possibility of increased integration between these large issue-driven domains.

Conclusions

This doctoral project consisted of a larger case study, made up of several smaller studies, each concerned with a different time frame. Together they built a layered picture of the evolution of the NHRP within the larger context of the research response to the Canterbury Earthquake Sequence. The use of this national coordination mechanism made this an unusual post-disaster research environment, and the analysis indicated that this approach was effective in sustaining research quality while also providing science support for response and recovery agencies.

The explanatory force of this framework's focus on systemic effects, and particularly domain drivers, clarified in the first instance just how difficult it was for this organization to continue to "promote cooperation within the scientific and technological communities and facilitate a science-policy interface for effective decision-making in disaster risk management," a Sendai Framework priority area for action (UNISDR 2015, p. 13). Secondly, the framework provided valuable insights into why this task became so difficult over time. The strength of domain drivers working against cross-boundary activity and networking was evident in decision-making about coordination and organizational parameters, and in the ongoing drag back towards pre-existing component domains, organizations and networks, which contributed to the invisibility of the cross-boundary initiatives, and over time had a fragmenting influence on the larger grouping. Thirdly, the framework provides insights into the balancing, incentivizing and accountability measures required to reduce the difficulty of this task by alleviating the fragmenting force of these drivers.

The preceding chapters have each concluded by drawing attention to the value of the lessons provided through these insights offer to those planning, designing and implementing research coordination efforts after disasters. As well, although predominantly drawn from the operation of a boundary organization in a post-

disaster environment, many of these lessons were also found to be more widely applicable to disaster risk management coordination efforts across domain boundaries. A key finding has been that the early establishment of the NHRP in usual conditions was a major factor in this boundary organization's ability to facilitate research coordination in support of response and recovery decision-making after this disaster, without compromising research quality. It had already been set up as a coordination mechanism, designed to network the science community in such a way as to bring the resources it offered to bear on national policy, strategy and decision-making, and so on the management of national disaster risk in more usual times. Olshansky et al. (2012) propose that disasters greatly accelerate, rather than fundamentally alter, the contemporary decision-making environments involved in urban development activities. This has been a consistent theme in this doctoral project, informed by the conceptual focus on systemic effects. Applied at both detailed and wider levels to the issues, risks and opportunities that emerged in this New Zealand post-disaster decision-making environment, this focus on systemic effects has clarified the differentially magnifying effect of this environment on tensions that are generated by domain drivers in all contemporary decision-making environments. In addition to drawing from Olshansky et al. (2012), these findings provide further evidence for the idea that they propose: that post-disaster environments differ from others largely because disasters create a surge in the extent and speed of existing contemporary change processes, which creates what they call post-disaster time-compression. Olshansky et al. (2012) suggest that since this is the case, it may be that existing urban development and planning approaches can be usefully adapted for application in the post-disaster context. The boundary management framework is widely used in urban development and planning contexts. As applied as in this thesis, it is equally useful as an analytic tool in the post disaster context. Two further closing points about this utility serve to link this project's findings into the larger, global context.

Firstly, the use of a framework applicable in both post-disaster and general or usual settings helped to clarify the extent and nature of the changes associated with time compression, while also underlining the continuities between both

environments. The project found, for example, that time-compression created an urgent need for specialized management and coordinating arrangements to manage the increase in complexity of the post-disaster environment. Bearing out the literature calling for the coordination of post-disaster research in particular, these findings also reinforced the need to ensure that such coordination is part of the larger integrated effort that brings resources from a wide range of domains and sectors to bear on post-disaster decision-making. The establishment of the NHRP in order to carry out this function in the years before the disaster, however, underlines the continuity between these environments – although aggravated by disasters, the requirement for coordinated support for the science-policy interface for disaster-related decision-making is far from unique to the post-disaster environment.

This brings into question current conceptual and administrative distinctions between domains specializing in disaster risk reduction in usual times, and those more directly related to disaster events. This division has a long history, and remains internationally current, informing, for example, the arrangement of the priority action areas in the Sendai Framework. Areas 1, 2 and 3 are concerned with understanding risk, risk management and resilience (respectively) in usual times, while Area 4 is concerned with disaster events (including preparedness, and response and recovery). The findings of this project suggest, however, that this conceptual and administrative structure (and the agency, disciplinary and practical specialist divisions associated with it) risks obscuring the continuities between these aspects of disaster risk reduction. Using a conceptual framework with explanatory force that includes all aspects of the large, highly complex set of issues involved in disaster risk reduction reduces this risk, while findings concerning tensions between specialist domains lend weight to questions concerning the value of dividing the disaster risk reduction issue on the basis of direct and immediate relation to disaster events.

A second advantage concerns the relevance of findings concerning processes that have been magnified or rendered more visible in the post-disaster environment to other environments. This project began with reference to the gathering pace at

which decision-making environments are becoming globalized, and consequent rise in reliance on non-government sectors for policy and decision-making support. Manifestly an effort to coordinate and manage such support, the NHRP is one of many emerging initiatives set up in an effort to maximise opportunities to address complex issues with significant consequences, while minimising the risks associated with decision-making processes that are not subject to democratic process. Already positioned to attempt this task, the NHRP was thus well placed to respond to the sudden increase in need for support after disaster, underlining the extent to which the post-disaster support requirement was a magnified version of that involved in more usual social change processes. It follows that the time-compressed post-disaster environments can clarify the trends, patterns, risks and opportunities that are occurring at a slower rate as part of capital depletion and creation processes in the larger global system. Compressed in time, post-disaster environments can thus offer insights that relate to decision-making environments coming under increasing pressure to engage with the complex emerging challenges – including climate change, biodiversity loss, as well as disaster risk – that have been linked to accelerating globalisation.

This project found that time-dependent processes were vulnerable to post-disaster time compression immediately after disaster events, suggesting that the inhibition of these activities is closely related to the wave of accelerated capital depletion and spike in demand for resources immediately following the event. The need for science support after the Christchurch Earthquake created a heavy reliance on pre-existing knowledge, networks and specialist expertise. As the initial wave of capital depletion began to transition into the acceleration of capital creation effected through and as disaster recovery, escalating consensus-building emerged as a crucial component in the suite of accelerated processes through which this occurs. New recovery networks, knowledge, programs and capacity were part of the new social capital and institutional formation beginning to emerge through those processes. This was not replacement of existing knowledge, networks and capital, however, since these facilitated, and in some cases formed the foundation, of those produced through the new round of consensus building. As a magnified glimpse of accelerated contemporary change

processes, these findings point to the importance of retaining a focus on the value of maintaining, as much as possible, existing structures, knowledge and capacity. These are likely to play an important part in the accelerated consensus building involved in the production of new kinds of capital. As an indication of a likely near future, the findings of this project suggest that policy and other domains and sectors are likely to be increasingly interdependent, contributing to policy and other decision-making through an increasingly networked decision-making environment.

This is certainly the direction driven by current initiatives. The UNISDR Sendai Framework for Disaster Risk Reduction is a pertinent and influential recent example. One of its founding governance principles states that disaster risk reduction depends on the creation of just such a networked decision-making environment:

disaster risk reduction depends on coordination mechanisms within and across sectors, and with relevant stakeholders at all levels, and it requires the full engagement of all State institutions of an executive and legislative nature at national and local levels and a clear articulation of responsibilities across public and private stakeholders, including business and academia, to ensure mutual outreach, partnership, complementarity in roles and accountability and follow up (p.8 UNISDR 2015).

Finally, then, three comments on the implications the findings of this project have concerning this principle.

The first concerns the magnitude of the task involved in establishing a disaster risk reduction platform on the scale envisaged in this principle. New Zealand has a history of exposure to disaster events, and a strong culture of hazard and disaster risk management. This is reflected in the large proportion of action items listed at the national level that are already part of this country's national suite of disaster risk management measures. The most pertinent example is the NHRP itself, established as part through a government effort to 'promote and improve

dialogue and cooperation among scientific and technological communities, other relevant stakeholders and policymakers in order to facilitate a science-policy interface for effective decision-making in disaster risk management” (UNISDR 2015, p. 11). It is sobering, then, that the fragmenting effect of domain drivers over time, and the associated persistence of existing structures, networks and assumptions made this New Zealand pilot platform’s coordination effort extremely difficult, despite the fact that it was operating in a developed country with a strong culture of hazard and disaster risk management, and networks in both research and policy domains. The findings of this doctoral project indicate that the much greater scale of the task outlined in the governance principle (above) would require great commitment and resourcing across all the domains and sectors involved. Success would also depend on the extent to which attention was paid to establishing measures designed to balance such commitment and engagement across the domains and sectors in question, and also through the design, establishment and implementation phases of the proposed arrangement.

Conversely, however, the wide scale and inclusive scope of this principle are entirely consistent with this project’s findings concerning what would be required to address the difficulties faced by the NHRP. The NHRP’s position in the research domain, and associated lack of direct policy engagement in organizational decision-making processes contributed to difficulties contributing to policy strategy, and in producing research outputs that were relevant as well as credible. These difficulties would have been considerably reduced by the full engagement of all State institutions of an executive and legislative nature at national and local levels called for above. Similarly the references to the clear articulation of responsibilities and accountability and follow up point to measures that would address some of the legitimacy issues associated with the NHRP’s difficulty to establish and maintain a profile.

The short life span of the Advisory Group emphasized the advantage conferred by the NHRP’s greater scale, more inclusive parameters and the funding and authority conferred by its official role, when it came to adapting in response to agency demand. The increase in scale, inclusive parameters and finding and

authority between the NHRP and the proposed national disaster risk reduction is of a similar order of magnitude. This is to suggest that, although daunting, the magnitude of the coordinating operation suggested in this principle, including the extent of government engagement and the inclusion a much greater range of sectors and stakeholders, may ultimately make the task of implementing and maintaining such a platform less difficult over time.

I want to conclude with some final comments about the value of the boundary management's focus on systemic effects. It serves to draw attention to drivers so fundamental, and intuitively obvious, that they work in the background, as the founding assumptions that drive activities at all levels in the domain. It is obvious that activities in the science domain are driven by the need to ensure scientific credibility, and that activities in the policy domain are required to be politically relevant. The value of this framework is that it clarifies the less obvious effects of these drivers as they inform incentive regimes and individual behaviours, and the tensions that inevitably arise when they come into conflict around domain boundaries. The focus on systemic effects offers to defuse these tensions, in part by clarifying the extent to which they are not caused by individuals, or even the activities of a sector, but are instead the complex effects of simple rules. This framework thus offers a useful counterbalance to blame attribution, and helps to clarify highly sensitive issues.

As well, however, the framework has a defusing effect because these drivers are so fundamental. Both are necessary, which is what emerges when attention is turned to the issues that have made cross-boundary collaborations so difficult. Boundary organizations like the NHRP are required to ensure that processes and outputs are both scientifically credible and relevant to policy strategy and agency need. Out of this need emerges the drive for balance – while it is a goal, like the other two drivers, it is also a functional requirement for cross-boundary activity. A lack of balance between domain influences, or stakeholders, will inevitably dictate that the relevant initiative will be less effective at achieving both relevance and credibility, and this will put the legitimacy of the initiative at risk.

It has been well established that the blurring of the boundaries dividing policy and

other domains has been driven by globalisation, and that it carries a range of new risks and opportunities. The pressure for integration has been situated at the policy end of the spectrum of tensions between the science and policy domains (Parker & Crona 2012), and in addition to posing risks to the democratic process, such expansions of the boundary zone between policy and science can carry significant risks to scientific credibility (Jasanoff 2011A, B). This project has been concerned, however, with the opportunities associated with this shift towards more integration across the science/policy boundary, and across sectors. It appears that much of this opportunity arises because the drive for balance and inclusion is a fundamental requisite cross-boundary activity. That the legitimacy drive should be emerging as a functional effect of the globalisation of decision-making environments, and as inequities grow, is a ground for optimism.

Appendix 1: Table 4: Disciplinary categories provided as meta-data in WoS publication data sets, coded as STEM or non-STEM, and including comparative percentages of total data-set items.

STEM or non	Disciplinary field	as % of each data set			
		CES	HE	BS	HK
non	Anthropology		<1		1
non	Anthropology; Sociology				<1
non	Archaeology				<1
non	Area Studies		1		
non	Business				1
non	Business, Finance				1
non	Business; Communication		1		1
non	Business; Management	2	1	1	<1
non	Business; Planning & Development			1	
non	Communication		2	8	2
non	Criminology & Penology			1	<1
non	Cultural Studies		<1		<1
non	Ecology	1	<1	2	2
non	Economics		1		2
non	Education & Educational Research	1	2	1	1
non	Environmental Studies; Geography		1	1	1
non	Environmental Studies; Management		<1	1	1
non	Environmental Studies	3	<1	6	<1
non	Ethnic Studies		2		1
non	Family Studies		<1		<1
non	Folklore				<1
non	Geography, human	3	2	3	<1
non	Health Policy & Services	1	2	3	4
non	History		1		1
non	Hospitality, Leisure, Sport & Tourism			2	<1
non	Humanities, Multidisciplinary		<1		<1
non	Industrial Relations & Labor				1
non	Information Science & Library Science		<1	1	<1
non	International Relations		2		<1
non	Law				1
non	Literature		1		<1
non	Music				<1
non	Nursing	<1	2	2	2
non	Planning & Development	<1	3		1
non	Political Science		1		3
non	Psychology	2	2	1	7
non	Public Administration	<1	1		4
non	Rehabilitation		1		<1
non	Religion		<1		
non	Social Sciences		<1		1
non	Social Work	<1	<1		1
non	Sociology			1	2
non	Theatre	1			

non	Urban Studies				1	
non	Women's Studies				<1	
STEM	Agronomy; Water Resources				<1	
STEM	Allergy; Immunology				<1	
STEM	Anesthesiology		<1			
STEM	Architecture				<1	
STEM	Astronomy & Astrophysics;		1		<1	
STEM	Automation & Control Systems;				<1	
STEM	Biochemical Research Methods				<1	
STEM	Biochemistry & Molecular Biology;				<1	
STEM	Biodiversity Conservation; Environmental Sciences				<1	
STEM	Biodiversity Conservation; Fisheries				1	
STEM	Biology; Mathematical & Computational Biology				<1	
STEM	Biotechnology & Applied Microbiology;				<1	
STEM	Cardiac & Cardiovascular Systems		<1		<1	
STEM	Cell biology		<1			
STEM	Chemistry				1	
STEM	Clinical Neurology		2		<1	
STEM	Computer Science		1	3	6	3
STEM	Critical Care Medicine			3	1	1
STEM	Demography					1
STEM	Dermatology			1		<1
STEM	Emergency medicine			1		1
STEM	Endocrinology & Metabolism					<1
STEM	Engineering,		37	13	3	13
STEM	Entomology			<1		1
STEM	Environmental Sciences		2	<1	4	4
STEM	Food Science & Technology			<1		
STEM	Forestry				8	1
STEM	Gastroenterology			<1		
STEM	Genetics & Heredity					<1
STEM	Geochemistry & Geophysics		12	5		1
STEM	Geography, physical		2	3		1
STEM	Geology			<1		<1
STEM	Geosciences, Multidisciplinary		17	8	1	3
STEM	Geriatrics & Gerontology					1
STEM	Horticulture					<1
STEM	Infectious Diseases			2		1
STEM	Marine & Freshwater Biology					1
STEM	Mathematical and computational biology			<1		<1
STEM	Medical Laboratory Technology			<1		<1
STEM	Medicine, General & Internal		1	4	2	3
STEM	Medicine, Legal			<1	16	<1
STEM	Medicine, Research and Experimental					<1
STEM	Meteorology & Atmospheric Sciences				7	3
STEM	Microbiology			<1		<1

STEM	Multidisciplinary Sciences	3	1	1	1
STEM	Nanoscience				<1
STEM	Neurosciences	<1			<1
STEM	Obstetrics & Gynecology		<1		<1
STEM	Oceanography		<1		1
STEM	Operations Research		<1		
STEM	Ophthalmology				<1
STEM	Optics		1		
STEM	Ornithology				<1
STEM	Orthopedics		2		<1
STEM	Otorhinolaryngology; Surgery				<1
STEM	Pathology				<1
STEM	Pediatrics	<1	1		<1
STEM	Peripheral vascular disease		<1		
STEM	Pharmacology & Pharmacy				<1
STEM	Physics	<1	<1		<1
STEM	Psychiatry	1	2	1	1
STEM	Public, Environmental & Occupational Health		10	4	6
STEM	Radiology, Nuclear Medicine				<1
STEM	Remote Sensing;	<1	2		<1
STEM	Rheumatology	<1			
STEM	Robotics				<1
STEM	Soil Science	<1			
STEM	Spectroscopy				<1
STEM	Statistics & Probability				<1
STEM	Surgery		2	1	<1
STEM	Telecommunications				<1
STEM	Thermodynamics; Energy & Fuels				<1
STEM	Toxicology				<1
STEM	Urology & Nephrology	<1	<1		1
STEM	Veterinary Sciences		<1		<1
STEM	Zoology				<1

Table 5: Broad categories of CES-related research activity coordinated through the NHRP

List Of Acronyms (In Alphabetical Order) Used In Table 5:

Geological sciences	Aerial photography and LIDAR; ground penetrating radar (GPR); landslide/rockfall data; seismic fault trace data; aftershock shaking data	Establishing uplift and subsidence; modelling seismic stress re-distribution, aftershock forecasting, mapping the fault trace; identification of other seismic features; quantifying contributions to seismic hazard, stochastic ground motion simulation of Chch Earthquakes, mapping seismic faulting in the region; dynamic updates of state of current knowledge to inform agencies and the industry	UC, GNS, VUW, (NZ) & international research partners	<p>End-users included:</p> <p>CDEM, CERA, OPMSA, TEC, MoE, MSD, CCC, WDC, SDC, ECAN, EQC, DBH/EAG;</p> <p>Also: Te Rūnanga o Ngāi Tahu; Aecom; small & medium business organisations</p> <p>Research informed:</p> <p>response & recovery decision-making;</p> <p>land use and other planning decisions including land zoning legislation;</p> <p>changes to building codes and practices;</p> <p>(2012) Royal Commission of Inquiry into Building Failure Caused by the Canterbury Earthquakes.</p>
Social Sciences	Immediate and medium term social, demographic and economic impacts; Disaster risk and resilience data.	Research advice and assessments: psycho-social support regimes and information provision for individuals, staff, organizations and communities impacted by the earthquakes; socio-economic impacts of the earthquake on urban and rural businesses and communities; disaster resilience, community resilience and recovery monitoring; predictions of population and capital 'flight', and other short/medium term demographic and economic changes following damage, red-zoning and response, recovery and rebuild operations; risk communication	MU, UC, GNS, LU, UoO, Opus; private providers of psycho-social support and research	
Geotechnical Engineering	Liquefaction-related land and foundation damage; aerial photography liquefaction; slope stability data	Risk assessments/safety issues; liquefaction mapping; establishing lateral displacement; mapping rockfall and landslide risk, including modelling rockfall trajectories; geotechnical life safety assessments	UC; GNS; UA; Tonkin & Taylor; international research partners; Opus; other private providers	
Structural Engineering	Seismic performance of structures – buildings and infrastructure.	Structural damage and safety assessments; dynamic updates of state of current knowledge to inform agencies and the industry; basic research on seismic performance of wide range of structures and buildings; seismic site response effects, acceptable seismic risk of older buildings, retrofit solutions for heritage unreinforced masonry buildings.	Leads: UC and UA – included GNS, BRANZ and private providers; international research partners	
Lifeline & Natural Resources Engineering	Seismic performance of lifelines & pipe networks/systems; disaster waste management; groundwater contamination of aquifers	Damage and performance assessments, including interdependence; waste disposal options; reinstatement of lifeline services; design new lifeline approaches and solutions	UC; UA; GNS; Opus; private providers, international research partners	

BRANZ – Funded by New Zealand Building Research Levy to invest in building research & provision of testing, research advice & knowledge. (www.branz.co.nz)

CCC – Christchurch City Council (one of the three territorial authorities impacted by the Canterbury Earthquake Sequence) (www.ccc.govt.nz)

CERA – Canterbury Earthquake Recovery Authority; established by the Canterbury Earthquake Recovery Act (2011).

DBH – Department of Building and Housing, a branch of the Ministry of Business, Innovation and Employment (MBIE). (www.dbh.govt.nz)

DBH/EAG – Department of Building and Housing Engineering Advisory Group (www.dbh.govt.nz/canterbury-earthquake-eag)

ECAN – Environment Canterbury, the Canterbury Regional Council, New Zealand (the regional council impacted by the Canterbury Earthquake Sequence).

GNS – GNS Science, New Zealand Crown Research Institute (CRI) established by the CRI Act (1997).

LIDAR – remote sensing technology using lasers to measure distance

MU – Massey University, New Zealand

MoE – NZ Ministry of Education

MSD – NZ Ministry of Social Development

NZTA – New Zealand national transport authority

Opus – private NZ research provider

OPMSA – Office of the Prime Minister’s Chief Science Advisor - www.pmcsa.org.nz

SDC – Selwyn District Council (one of the three territorial authorities impacted by the Canterbury Earthquake Sequence) (www.selwyn.govt.nz)

Stanford – Stanford University, California, US (www.stanford.edu)

Tonkin & Taylor – private NZ research provider

TEC – New Zealand Tertiary Education Commission

Te Rūnanga o Ngāi Tahu – New Zealand tribal organisation with traditional authority in the Canterbury region (www.ngaitahu.iwi.nz/te-runanga-o-ngai-tahu)

UA – University of Auckland, New Zealand

UC – University of Canterbury, New Zealand

UC Berkeley – University of California, Berkeley campus, US

UoO – University of Otago, New Zealand

VUW- University of Victoria, Wellington, New Zealand

WDC – Waimakariri District Council (one of the three territorial authorities impacted by the Canterbury Earthquake Sequence) (www.waimakariri.govt.nz)

Table 6: PRAG tasks numbered 1-20 in order of inception date. Note that specific tasks have not been ascribed to named agencies, as per the consent form. In the text, agencies are named in relation to tasks already ascribed to those agencies in the public domain (Mooney et al. 2011).

Ref #	Inception date task	Completion date task	Task title	Task outline	Task initiator
1	11/03/11	1/03/11	Psycho-social Recovery Advisory Group Terms of Reference	Request for Terms of Reference document for provision to agencies and others requiring PRAG services.	Agency 1
2	16/03/11	22/03/11	Internal discussion of scientific advice delivery model	Discussions about the distinction and interface between mental health services and delivery of a wider set of mental health interventions.	Self-initiated (Agency 1 included in some emails)
3	17/03/11	24/03/11	Commentary re: Offer of assistance (and request for funding) from Australian based company specialising in psychosocial advice and training	Request for commentary on request/offer from Australian company wishing to be contracted to provide psycho-social recovery training. Comments provided.	Agency 1
4	23/03/11	1/04/11	Commentary re: a Disaster Relief NGO active in Christchurch	Request for clarification concerning an international NGO (operating at the time in Christchurch). Clarification was provided re (UN) auspices and contact details for NGO representative.	Agency 1
5	24/03/11	1/11/11	Updates to ToR and Psychosocial Annex Document	Ongoing refinement of ToR, compilation of Psychosocial Annex Document	Self-initiated
6	25/03/11	28/03/11	Commentary re: Individual Recovery and Community Wellbeing Volunteer Training Services Application form	Request for feedback on application form to be completed by individuals and groups volunteering in response and recovery. Comments provided.	Agency 1
7	29/03/11	5/04/11	Commentary re: Supporting Individual and Community Recovery Strategy, and National Planning Framework for the Psycho-Social Response	Request for feedback on both strategy and plan before sign off. Comments provided.	Agency 1
8	30/03/11	5/04/11	Commentary re: NGO Intervention	Request for clarification and commentary on NGO initiative providing psychosocial support program for children delivered by US experts. Comments provided included contact details for program representatives.	Agency 1
9	01/04/2011	10/05/11	Engagement in: Agency 2 psycho-social recovery briefings	Psycho-social recovery workshop involving PRAG members and Agency 2; subsequent commentary on minutes from the workshop; PRAG invited to participate by Agency 2 to participate in support of Agency 2's briefing presentation to CERA on psycho-social recovery	Agency 2
10	6/04/11	1/11/12	Project: Indicators and measures of recovery	The possibility of a project identifying indicators and measures of successful psycho-social recovery was raised with the PRAG before monitoring responsibility passed to CERA	Agency 1

11	15/04/11	12/06/11	Engagement in: Social and economic costs of non-intervention literature review	Provision of 22 page literature review.	Agency 3
12	1/05/11	22/08/11	Engagement: NZPsS conference presentation	Invitation to contribute Psychosocial Recovery presentation at 2011 New Zealand Psychological Society Conference	New Zealand Psychological Society
13	1/07/11	17/02/12	Engagement: Journal article for NZ Journal of Psychology	Invitation to publish an article based on the conference presentation in the New Zealand Journal of Psychology	New Zealand Psychological Society
14	27/07/11	15/08/11	Commentary re: Particular non-medical approach to treating post-traumatic stress	Request for rapid commentary on a particular non-medical treatment technique. Comments included recommending requiring registered practitioners, and treatments founded on a scientific evidence-base.	(Private consultant)
15	1/08/11	30/10/11	Commentary re: draft CERA framework	Comments provided on the draft CERA framework (as part of wider consultation process workshoping the document).	Agency 4
16	20/03/12	20/05/2012 (approx)	Commentary re: CERA Community Events Planning	Commentary provided in the form of an eleven page summary of available literature, including examples of community-initiated memorial events, and key principles.	Agency 4
17	10/01/12	17/01/12	Application for funding for joint research project	Funding application compiled and submitted for joint research project concerning public health approaches to addressing CES-related fear and avoidance (application was unsuccessful)	Self initiated, in collaboration with Agency 3
18	12/04/12	10/05/12	Self Assessment project	Development of survey questionnaire to gather feedback from PRAG members; there was also discussion concerning a survey questionnaire for agencies. Neither survey had been finalised or distributed when the PRAG ceased (June 2012).	Self-initiated
19	18/05/12	12-Jun-12	Commentary re: Guiding principles for evaluation of community initiated remembrance proposals	Request for commentary on community remembrance proposals. Comments provided.	Agency 4
20	30/05/12	5/06/12	Commentary re: Use of existing wellbeing scales in CERA Wellbeing Survey	Request for commentary concerning possible utilisation of existing well-being scales. Comments provided.	Agency 4

Appendix 4: Human Ethics Committee approval letter for the Advisory Group case study, with examples of participant consent forms and information sheets.



HUMAN ETHICS COMMITTEE

Secretary, Lynda Griffioen
Email: human-ethics@canterbury.ac.nz

Ref: HEC 2014/21/LR-PS

3 November 2014

Sarah Beaven
Department of Geological Sciences
UNIVERSITY OF CANTERBURY

Dear Sarah

Thank you for forwarding to the Human Ethics Committee a copy of the low risk application you have recently made for your research proposal "The Psycho-social Research Advisory Group (PRAG) - a case study of research advice and collaboration after the 22nd February Christchurch Earthquake".

I am pleased to advise that this application has been reviewed and I confirm support of the Department's approval for this project.

The committee wishes to emphasise strongly that ensuring confidentiality of the correspondence is vital given that typically such information flows are seen as drafts and, if released under the Official Information Act, would have the participant's names redacted. Furthermore, if participants in PRAG decline to have their correspondence in the study, the researcher must absolutely guarantee that.

With best wishes for your project.

Yours sincerely

A handwritten signature in black ink, appearing to read 'L. MacDonald'.

Lindsey MacDonald
Chair, Human Ethics Committee

Research Consent Form

Department of Geological Sciences

Telephone: +64 211102442

Email: sarah.beaven@canterbury.ac.nz

[Date]

Project title: 'The Psycho-social Recovery Advisory Group (PRAG) – a case study of research advice and collaboration after the 22nd February Christchurch Earthquake.'

Consent Form for PRAG advisors and clients

I have been given a full explanation of this project and have had the opportunity to ask questions. I understand what is required of me if I agree to take part in the research. I understand the risks associated with taking part and how they will be managed. I understand that consent is voluntary and I may withhold it any time without penalty. Withholding consent will also include the withdrawal of any information provided on the basis of my granting consent, should this remain practically achievable.

I understand that any information or opinions provided on the basis of this consent will be kept confidential to the researcher (Sarah Beaven) and her supervisory committee, namely Thomas Wilson, Lucy Johnston, David Johnston, Richard Smith, and that any published or reported results will not identify individuals, or organisations. I understand that a thesis is a public document and will be available through the UC Library, and that I am able to receive copies of any articles or other outputs based on this case study by contacting the researcher at the conclusion of the project.

I understand that all data collected for the study will be kept in locked and secure facilities and/or in password protected electronic form and will be destroyed after five years. I understand that I can contact Sarah Beaven

(sarah.beaven@canterbury.ac.nz) or her supervisor, Thomas Wilson (thomas.wilson@canterbury.ac.nz) for further information. If I have any complaints, I can contact the Chair of the University of Canterbury Human Ethics Committee, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz)

By signing below, I agree to participate in this research project.

Name:

Date:

Signature:

(Please send a scanned, signed and dated form by email to sarah.beaven@canterbury.ac.nz)

Research Information Sheet

Department of Geological Sciences

Telephone: +64 211102442

Email: sarah.beaven@canterbury.ac.nz

[Date]

Project title: 'The Psycho-social Recovery Advisory Group (PRAG) – a case study of research advice and collaboration after the 22nd February Christchurch Earthquake.'

Information Sheet for PRAG advisors and clients

Principal Researcher: Sarah Beaven (Research Associate and Doctoral Candidate, Department of Geological Sciences, University of Canterbury).

The Psycho-social Recovery Advisory Group case study has been designed to contribute to a larger, doctoral project, entitled 'Managing the science/policy boundary after disasters: a case study of the research response to the Canterbury earthquake sequence.' This doctoral project draws from the research field that applies insights from complexity theory in the analysis of complex social systems and organisations. It proposes to apply frameworks from boundary management theory to review the research response to the 2010-2011 Canterbury earthquake sequence (CES). The doctoral project has three related aims. In the first instance, it aims to establish the utility of the boundary organisation framework in the hazard and disaster context, in relation to both the analysis of the activities of existing large science/policy collaborations, and to the planning and design of future such collaborations across science and non-science boundaries. A second aim is to use this framework to analyse the management, during and after the CES, of the tensions and pressures generated around the science/policy boundary, and to draw lessons from this analysis concerning best practice in terms of balancing the

research needs of all stakeholders after disasters, and particularly those of researchers and research end-users. Thirdly, this project aims to use the lessons identified through this analysis in the development of a disaster research response model directly applicable in the New Zealand context. It is expected that the focus of this model on processes and functions will also make it relevant in a range of other national, cultural and geographical contexts.

The PRAG case study that is the subject of this participant consent request has been designed to contribute to the larger doctoral project described above. It will be largely based on the secondary data generated as part of PRAG advisory activity between March 2011 and June 2012, and currently held at the Joint Centre for Disaster Research, Massey University by the Chair of the PRAG.

Risks:

The PRAG Terms of Reference informed advisory activity, and were usually provided to clients requesting advice. These made it clear from the outset that PRAG activities would be publicly reported, and so available in the public domain.

This consent request relates, however, to the use of secondary data generated as part of these professional activities, including spreadsheets detailing advice requested and received, final reports provided by PRAG to clients, and email trails between PRAG members and clients. There are some risks associated with the use of this material, associated with the fact that you may not have expected that some of this secondary data, including emails and detailed reports, would be made available for research purposes. In order to minimise the risk of adverse outcomes to individuals or organisations, details identifying individual participants will not be included, and neither individuals nor organisations will be identifiable in discussions concerning the detail of requests and outcomes, beyond the distinction between the roles of PRAG members and clients. There is also some risk associated with the fact that the PRAG membership is small and publically available. This means that although material will not be attributed to individuals, it may not be strictly anonymous. Consent procedures and anonymity provisions have been designed to minimise the risks associated with the possibility that if this material were to become public, it might be disadvantageous to the participant.

The risks to individuals and organisations are also reduced to some extent by the focus of this research, which is not concerned with issues of individual or organisational performance or responsibility. The boundary management approach dictates a focus on the systemic processes used to balance tensions found to be inevitable in all collaborations across the science/policy boundary. The emphasis will be on the evolution of relevant functions and procedures in this advisory group's collaboration with clients requesting scientific advice and support concerning the Canterbury Earthquake Sequence over this time period.

All secondary data provided by the Chair of the PRAG to the researcher for the purposes of this research will be kept strictly confidential, and will be stored electronically on two hard drives which will not be connected to the cloud. It will

be destroyed after five years (mid-2019).

Since this is a doctoral project, I am also asking for consent to make this information available to members of the committee supervising the wider doctoral project, if and as the need arises, and as part of the supervision process only. Committee members are Dr Thomas Wilson (Senior Lecturer, Geological Sciences, UC) Professor Lucy Johnston (Professor of Psychology, Office of Vice-Chancellor, UC) Professor David Johnston (Director, Joint Centre for Disaster Research, Massey University, GNS Science) and Dr Richard Smith (Manager Research Investment, EQC).

Consent is voluntary and you have the right to withhold it at any stage without penalty. If you withhold consent, I will remove relevant references from any outputs should this remain practically achievable.

You may receive a copy of any articles based on this case study by contacting the researcher at the conclusion of the project. A Ph D thesis is a public document and will be available through the UC Library.

The project is being carried out as part of a Ph D in Hazard and Disaster Management, by Sarah Beaven, under the supervision of Thomas Wilson, who can be contacted at thomas.wilson@canterbury.ac.nz. He will be pleased to discuss any concerns you may have about participation in the project.

This project has been reviewed and approved by the University of Canterbury Human Ethics Committee, and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

If you agree to participate in the study, I would appreciate it if you would complete the consent form also attached to this email and return it as a scanned document attachment by email to (sarah.beaven@canterbury.ac.nz) (If you are using Preview to open this PDF, you can use the signature function to sign it electronically).

If you prefer to withhold consent, I would appreciate it if you would inform me of this preference at the same email address.

sincerely

Sarah Beaven

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