Disastrous Doctorates

The 4th Annual Meeting of Doctoral Disaster-related researchers

Programme and Abstracts

March 11th 2011

Joint Centre for Disaster Research,

Massey University and GNS Science, Wellington

Editor: Dr. Caroline Orchiston

JCDR Research Report 2011/01

Disastrous Doctorates Agenda

Room 5B14

9.45am Arrival

10.00am Introduction (Caroline)

- aim of the workshop
- agenda for the day
- round-table introductions

10.30am Morning tea

10.45am PhD topic overviews:

- 5 minutes each (verbal overview is fine, or you are welcome to present up to 5 powerpoint slides on memory stick)

12.30pm Lunch

1.00pm Discussion – including, but not restricted to:

- methodologies
- papers/publications
- supervision
- funding
- opportunities in the real world - a discussion on how interaction with other individuals and organisations can enhance your research and provide a pathway for future opportunities

3pm Afternoon tea

4.00pm Close of workshop

5.30pm Barbeque outside the JCDR office, with attendees of the Summer Institute

List of Attendees

Dr. Caroline Orchiston – Convenor

Wayne Severn – Ministry of Science and Innovation (observer)

Attendee	Institution	Email address
Heather Taylor	University of Canterbury	Heather.taylor@pg.canterbury.ac.nz
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Mary Anne Thompson	University of Auckland	m.thompson@auckland.ac.nz
Victoria Sword-Daniels	University of Canterbury	victoria.sword-daniels.09@ucl.ac.uk

Disastrous Doctorates 2011 Attendees

Front row (left to right): Heather Taylor, Kim Rait, Patrick Kailey, Jennifer du Bois, Joanne Stevenson, Mary Anne Thompson, Victoria Sword-Daniels.

Back Row (left to right): Caroline Orchiston, Stuart Fraser, Sally Grant, John Lindsay, Julia Becker, Brenda Mackie, Colin Whittaker, Zach Whitman, Vicki Johnson, Karlene Tipler, Vivienne Bryner. (Absent: James Hudson, Hlekiwe Kachali).

Micromechanical Behaviour of Sturzstrom

Kim Rait

University of Canterbury

Sturzstrom, or giant rock avalanches, generally occur in areas of pre-fractured ground mass and tectonic activity. A large amount of source rock falls initially as a rock fall or slide then quickly becomes a dynamically disintegrating rock flow that travels upwards of 30 times in horizontal distance as its initial fall height, and often at excessive speeds. Deposits show preserved stratigraphy and inverse grading with fine rock particles at the base and large angular boulders at the top. In mountainous areas sturzstrom are an extreme natural hazard and have caused multiple fatalities in the past.

Researchers agree that a mechanical behaviour is responsible for the long runout and fragmented deposits found at sturzstrom sites. Research on fracture and fragmentation in brittle materials has shown that inherent flaws in rock and the energy provided from an exterior stress are both important for fragmentation to occur. Under a compressive stress, rock has been found to rupture as these inherent flaws fork and coalesce. Dynamic tensile stresses occurring from a rapid deposition of energy through contact forces can cause a brittle material to explosively fragment.

In a sturzstrom event, it is thought that multiple dynamic or explosive fragmentation events occur at or near the base of a sturzstrom. These fragmentation events produce both fine rock material and rock clasts. The isotropic dispersive pressure created by the multiple fragmentation events may cause the fine rock material to behave like a pressurised fluid. This causes a reduction in effective stress and friction and may explain the long run out behaviour of sturzstrom.

Discrete Element Modelling (DEM) is being utilised to create and test rock particles under varying overburden pressures to investigate the effect of fragmentation behaviour at varying depths in a typical sturzstrom. The most important part of this modelling is correctly representing a sturzstrom sample which involves producing rock clasts surrounded by a matrix of fine material.

Additional to DEM, the Iverson & Denlinger (2001) Coulomb mixture theory will be used to investigate what overall effect an isotropic dispersive pressure will have on run out of a sturzstrom. This particular theory builds on the original Savage & Hutter (1989) granular flow theory by replacing the pressure tensor with a stress broken into solid and fluid parts. This theory allows intergranular pore fluid pressures to influence Coulomb friction and is suitable for highly collisional flows such as sturzstrom.

Ultimately the intention is to couple the DEM and Coulomb mixture theory to allow the effects of the DEM testing to be passed to the continuum model to determine the effect of fragmentation on the runout of a sturzstrom.

A Kaikoura tsunami?

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The plausibility of a submarine landslide generated tsunami at Kaikoura Canyon

Supervisors: Tim Davies and Deirdre Heart

The head of the Kaikoura Canyon is located in close proximity to shore at Goose Bay in the Kaikoura district. Sediments are deposited regularly into the canyon from rivers to the south via longshore motion. These deposits, which already exhibit tensional fracturing, continue to build up in a tectonically active area. Rupture of the nearby Hope Fault or the more distant Alpine Fault, which is expected to occur every few hundred years, could induce failure on the deposits. The subsequent submarine landslide is expected to produce a tsunami of significant magnitude in the nearby Kaikoura township. There should presently be sufficient amounts of sediment to cause such a tsunami.

The failure of the Kaikoura Canyon sediments potentially could occur approximately every 100-200 years, in which case there should be sedimentological evidence in the Kaikoura region and prehistoric accounts in the form of oral histories and legends referring to extremely large waves or taniwha, sea monsters. If there is evidence that the Kaikoura Canyon will produce an appreciable tsunami then it will be necessary to determine how the people will react and what emergency measures need to be put into place.

Volcanic Hazards Simulation: A collaborative role-play exercise using multiple, synchronous time series datasets to perform volcanic forecasting and hazard management.

Jacqueline Dohaney, Ben Kennedy, Max Borella, Clay Hamilton, Darren Gravley

Predicting volcanic activity is a daunting task even for experienced volcanologists. We piloted a collaborative, face-to-face, role-play volcanic hazard simulation that is designed to teach practical skills necessary to forecast and manage a volcanic crisis. The original simulation was designed by Max Borella and Clay Hamilton for the Frontiers Abroad Programme. The purpose of the activity was to allow students to synthesize geological and geophysical monitoring data and make important decisions regarding the well-being of local citizens.

As part of the evaluation of the simulation, we interviewed volcanologists and volcanic hazard management professionals in order to identify their skills and their experiences with volcanic crises. Professionals identified that general communication and role specific decision making skills are critical when dealing with a volcanic crisis. The scenario was adapted with this in mind and students were assigned specific roles, but work collaboratively in two distinct teams. The Geology team focused on synthesizing, modeling, and forecasting the real-time volcano monitoring data, while the Emergency Management team reacts and manages volcanic effects and impacts. Instructors and invited volcanology professionals act as our 'experts', who guide and challenge the students during the simulation. The time series monitoring data streams (e.g. seismicity) were derived from the Mt. Pinatubo events of 1995 in New Zealand.

Two iterations of the simulation have been run with upper-year undergraduate and first year Masters level students. We have collected observation data and interview data with the purpose of exploring student engagement, decision-making, group dynamics, and effective curriculum design. Based on both data sets, several pedagogical factors have been identified as impacting student engagement and motivation: a. pace and run-time of the simulation, b. homework, reports and assessment of the simulation, c. level of interaction from experts, d. volcano data ambiguity, e. depth and authenticity of student roles.

These results and further investigation of interviews with students and professionals will be used to optimize future iterations of the volcanic hazard simulation. The eventual goal of the project is to adapt into a virtual learning environment.

Risk Perception and Warning Fatigue: the Australian Bushfires

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An ongoing frustration for hazard and disaster managers is the seeming lack of appropriate public response to recommendations that are devised to avert disaster and save lives. Why is it that some members of the public react appropriately to warnings, and yet others not only ignore, but often seem to deliberately act against advice?

What happens when authorities repeatedly alert the public about potential disasters that do not eventuate? 'Cry-wolf' syndrome, or 'warning fatigue effect' are generally recognised terms for cynicism or apathy that can result from being 'over-warned'. Warning fatigue poses a risk communication challenge where dissemination of "high alarm" messages that do not eventuate in an event of corresponding magnitude, can lead to reduced vigilance and preparation, despite the very real nature of the threat. To date there has been no empirical or robust psychosocial research into this effect, and my thesis will address this by exploring some of the following questions:

1) Does warning fatigue influence the perception of risk messages?
2) Is Warning Fatigue a 'one-off' or cumulative effect?
3) What is the size of this effect?
4) Is Warning Fatigue a function of time rather than frequency?
5) Does the media play a role in attenuating or amplifying Warning Fatigue?
6) Is there a congruence between risk messages (and their intended purposes), public understanding of these messages, and preparedness?

This thesis will explore whether warning fatigue is a reality for those individuals and communities threatened by potential bushfires and what, if any, are the consequences. It aims to provide agencies with ways to engage with communities by identifying issues associated with warnings processes and just as importantly, identify how to frame and communicate hazard warnings in ways that reduce the risk of warning fatigue and community complacency.

The impacts of volcanic ash fall on complex infrastructure systems

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Also collaborating with Massey University, University of Canterbury,

JCDR, & the British Geological Survey.

This research focuses on understanding the impacts of volcanic ash fall on complex infrastructure systems. The aim is to assess the risk by understanding vulnerability and resilience as its core components. A review has been undertaken to assess the extent of current knowledge on the impact of volcanic ash on critical infrastructure systems. It is found that existing studies are limited but do provide some insight into the impacts of volcanic ash on: health, structures, water and contamination, electrical appliances, agriculture and emergency management. Research gaps exist in the assessment of ash fall impact on complex infrastructure systems, such as the healthcare system, and in taking a long-term focus to risk management. Knowledge gaps have also been identified in tacking the complexity and interdependence of ash fall impacts, and treating vulnerability in a holistic way; to incorporate social and physical aspects of vulnerability, as well as interdependency, and the cascading consequences of any impact. A multidisciplinary and multi-method approach is being sought to understand complex system vulnerability and resilience. This is being undertaken using a systems thinking framework in order develop an improved methodology for holistic impact assessments. Investigative field studies have so far been undertaken on Soufrière Hills Volcano, Montserrat, and also surrounding Tungurahua volcano, Ecuador. Research is ongoing, with a particular focus on healthcare systems to gain new understanding the risk, vulnerability and resilience of coupled physical-social systems in long-term ash fall environments. This has applications for improved decision-making and the management of volcanic risk in urban areas.

The Potential for Using Mid to High-Rise Buildings as Vertical Evacuation Structures in Near-Source Earthquake and Tsunami Events

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Tsunami risk reduction programmes have historically focussed on educating the population at risk to evacuate to high ground in the event of a tsunami. In the case of low-relief coastal areas, distances the population are required to cover in order to reach sufficiently high ground may be too great, resulting in casualties and fatalities during the evacuation. This becomes a greater issue as warning time is reduced, i.e. following local earthquake events.

Vertical evacuation provides an alternative to evacuation inland or to high ground where this is not possible, and can be facilitated by existing high-rise buildings built for every-day use (e.g. office blocks or hotels) or structures built for purpose.

This research aims to assess the potential for using mid to high-rise buildings as vertical evacuation tsunami refuges, by assessing the performance of such structures with respect to earthquake ground shaking combined with subsequent tsunami wave loading. The peril combination of loads must be considered to account for local source tsunami events, in which there is potential for a structure to experience both significant ground shaking and wave impacts.

Also under consideration are the community aspects of vertical evacuation – how many evacuation structures are required, and where should these be sited in order to most effectively evacuate the population.

The outcomes of the project will be seismic and tsunami specific design criteria for vertical evacuation structures in general, with the intention that both the criteria and assessment methodology could be applied in any community facing a local earthquake and tsunami hazard.

The use of Bayesian Event Tree (BET) tools for probabilistic volcano hazard analysis (PVHA) and communication of volcanic risk in New Zealand

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Probabilistic volcano hazard analysis (PVHA) is still a relatively new tool for volcanologists. *Bayesian Event Tree for Eruption Forecasting* (BET_EF) and *Bayesian Event Tree for Volcanic Hazards* (BET_VH) are recently developed PVHA software programs that are being used in an increasing number of volcanic hazard studies. BET_EF and BET_VH models apply Bayes' Rule in a step-wise order of increasing detail to input information about geological models, past occurrences and expert opinion to generate short- and long-term probabilities of volcanic eruption and volcanic hazards, respectively. Effective BET tools could potentially play a significant role in the emergency management decision-making process by providing auditable quantitative risk probabilities in the event of volcanic activity. However, it is yet unclear how BET probabilities will translate into the decision-making strategies used by emergency management.

The aim of this study is to investigate the use and effectiveness of BET_EF and BET_VH for modeling volcanic risk in New Zealand and the translation of BET probabilities for comprehensible communication of volcanic risk to emergency management end-users. The goals of the study are to 1) develop a BET_VH model for the Okataina Volcanic Centre, 2) apply BET_EF retrospectively to the 1995-96 Mt. Ruapehu eruption, 3) analyze economic controls on the BET_VH evacuation thresholds for the Auckland Volcanic Field, and 4) conduct surveys of emergency management end-users to determine an effective method for communicating BET probabilities to emergency management decision-makers.

Understanding how individuals make meaning of earthquake information and how this relates to household preparedness

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Supervisors: Assoc. Prof. David Johnston, Prof. Douglas Paton and Prof. Kevin Ronan

In 2008, a total of 48 interviews were undertaken with residents in Timaru, Wanganui and Napier to explore how people understand and use information about earthquake hazards and preparedness. Three main sources of information were identified during the interviews: passive information (e.g. brochures, TV); interactive information (e.g. community activities; school activities; workplace activities); and direct and indirect experience (e.g. experiencing a hazardous event, responding to an event, working in an organisation that deals with hazards).

People used the information they received to form a variety of perspectives on hazards and preparedness. Hazards in people's minds range from natural hazards through to hazards that are more salient to daily life, such as workplace hazards or personal hazards. Preparedness may mean items collected specifically for an emergency, or items they already have in their house. People's understandings of these concepts shape how they respond in terms of actually getting prepared.

People tend to contextualise hazard and preparedness information around any core beliefs they have. For example if a person feels that safety is important, then they will contextualise hazards and preparedness information around this core belief, and will be motivated to prepare to ensure their safety. Likewise if an individual believes that an event 'can happen, anytime' they are more likely to take notice of hazards and preparedness information and be motivated to prepare. Other core beliefs that are important for motivating preparedness include a belief in the need for survival, that you could be on your own in a disaster, that an individual has the ability to prepare or respond, or that preparedness is a 'way of life'.

Experience of hazards (both direct and indirect) can have a profound impact on people's intention to prepare. People who have experienced a hazardous event realise that events 'can happen' and have a better understanding of the potential consequences, thus motivating them to prepare for future events. Some experience however can also lead to normalisation, whereby individuals think they fared adequately in a past event and so in a future event they will also get through it without needing to prepare.

Society also has an influence on how people interpret information and form intentions to prepare. People are often influenced by the opinions of others, and as preparing for disasters is not seen as a societal norm, this can cause people not to prepare. Feeling a responsibility for others (e.g. children) appears to be a big driver of preparedness; as if people feel a concern for

other's safety they are more likely to undertake preparedness actions. Other societal factors such as trust, leadership and sense of community also influence interpretation, dissemination and use of hazards and preparedness information.

Finally even if people do develop an intention to prepare for disasters, there are a number of resource issues that may prevent preparedness taking place. Such resource issues include: lack of knowledge; reduced capability; lack of time; cost; other priorities and a concern over where to store items once they are collated.

School and early childhood education services preparedness, response and recovery from the 2011 Christchurch earthquake

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NZ schools and early childhood education services (SECES) have an important role in not only preparing themselves as institutions, but also providing information to children and their families to enable them to respond effectively to emergencies and disasters.

This study aims to investigate how Christchurch SECES prepared for, responded to, and recovered from the 2011 Christchurch Earthquake. By comparing the actual emergency management (EM) practices of SECES with the requirements and expectations of EM agencies and practitioners any strengths, weaknesses, and gaps will be identified. These can then be used to develop an evaluation tool against which SECES efforts can be measured.

In order to achieve the research aim a mixed-method approach will be used combining both quantitative and qualitative research methods. This approach will allow flexibility in both data collection and analysis, while enabling triangulation of research methods and data sources that will increase the validity of the findings.

The study will be undertaken in four phases:

1. The development of an overarching framework for a resilient society which will provide the context for SECES role in community preparedness, response, and recovery;
2. The analysis of Christchurch SECES preparedness for, response to, and recovery from the 2011 Christchurch Earthquake;
3. The comparison of EM requirements and expectations with actual practices of SECES to identify key resilience indicators;
4. The development of an evaluation tool which can be used to measure SECES resilience.

Earthquake Science Communication for Disaster Risk Reduction

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This thesis explores theoretical and practical questions in the communication of earthquake science knowledge and associated possibilities in DRR in NZ.

Communication and story are introduced as primary human survival tools – a fundamental part of societal understanding and learning used purposefully, strategically, even persuasively to motivate individual and collective action. Attitudes toward objective and subjective knowledge, and ways in which society accepts, transmits, uses and applies science are discussed. Current thinking in managing risks and opportunities in reducing disasters in the context of public participatory process, and the ways that 'story' is currently used in DRR are summarised.

Research methods are content analysis of earthquake-related 'stories' in the public sphere, and interview with a range of societal actors. Content analysis - of print, TV and radio news, interviews and documentaries, magazine articles, selected website content, and classroom materials - will provide a clear picture of what 'science' is being communicated, where, when, how, and to whom. The interviews will provide the why - the motivations of those communicating the earthquake science and how these fit with DRR aims. Most importantly, interviews with journalists and writers, their 'expert' science sources, policy-makers, planners, politicians and 'the public', will establish the consensus as to the specific geoscience and DRR knowledge that will maximise achievement of DRR outcomes. Comparing these results with what content analysis has shown as having been typically communicated, will permit identification of possible opportunities to refine earthquake science communication for DRR.

The Quantification of Iwi Development

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Valid measures of Māori development are not easily quantified. Often, comparisons with non-Māori are made and further explored through life expectancy projections, morbidity and mortality rates, unemployment statistics, or educational outcomes. These types of indicators are useful measures of Māori progress but have often been criticised for being overly simplistic, deficit focused, or unable to offer useful and informed solutions. A more contentious issue concerns the type and range of indicators which are gathered and the extent to which existing data collections align with Māori aspirations and broader notions of Māori development. While certainly there is some value in collecting information on Māori employment, education, housing, or health, Māori development is likely to include a broader range of domains, importantly cultural domains – significant to Māori, but which are not often collected or difficult to measure.

This research aims to investigate the various components of iwi development and to construct a valid system through which iwi progress, from a Māori perspective, can be measured. It builds on previous work undertaken by researchers at Massey University which revealed the extent to which Māori ideals and perspectives of development differed from that of non-Māori. Moreover, while the components of iwi development could be articulated, accurate and valid measures were far more difficult to construct. Although Māori often saw value in the more conventional measures of progress, they were similarly interested in data which could inform them about tribal development, cultural capacity, Marae well-being, or environmental sustainability. This included indicators relating to the extent to which tribal members were aware of their genealogy, sites of significance, history, waiata, and basic tikanga and kawa.

The Modelling of tsunami generation and propagation

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Tsunamis represent a significant hazard to coastal communities. An increased understanding of tsunami events will enable these communities to be better prepared for their occurrence. Since the Boxing Day tsunami of 2004, interest and subsequent research in tsunamis has increased substantially. Previous research in this area can be broadly categorised as field surveys, numerical modelling or physical experiments.

This project aims to investigate the generation and propagation of landslide-generated tsunamis by carrying out both physical and numerical modelling, building on previous research by Sue (2007). A series of two-dimensional physical experiments will be carried out, using a mechanically-controlled rigid block landslide to determine the effects of slider motion and submergence depth on wave generation and subsurface velocity and pressure fields. This setup will allow a broad range of motion to be tested, as well as giving good experimental repeatability. Data will be acquired using the laser-induced fluorescence (LIF) and particle tracking velocimetry (PTV) techniques. The results of the physical experiments will be used to validate results from a numerical model based on inviscid-irrotational flow theory. A direct numerical simulation (DNS) using the program Gerris will investigate the effects of viscosity on numerical results. Physical and numerical experiments will be performed to examine three-dimensional effects on the generated wave fields.

Networks and neighbourhood effects on disaster recovery of organisations in Central Business Districts

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Organisations have been affected by and will recover from the September and February earthquakes in Canterbury very differently. More needs to be done to understand what makes organisations resilient, allowing them to recover effectively and thrive in the changing environment created by a crisis. Largely, individual organisations only have control over their own decisions and actions. However, organisations contribute to and are influenced by large dynamic systems. A business cannot be treated as an isolated unit. Organisations, develop and maintain complex networks that they may or may not access for aid in their recovery. Similarly, they are influenced by their surroundings within a business district. Thus, it is important to develop our view of CBD recovery as a dynamic and interconnected process. Businesses affected by the Darfield and Lyttelton earthquakes in Christchurch and Kaiapoi CBDs will be surveyed to explore two core questions: 1) How did the damage to and decisions of other businesses within a Central Business District influence the recovery of an individual business? and 2) How do a company's networks, the relationship with and location of their customers and suppliers, affect an organisation's resilience and their ability to recover?

Cross Cultural Perceptions of Risk from Natural Hazards in Christchurch, New Zealand

Zen Hadebe

University of Canterbury

PhD. Thesis, Hazard and Disaster Management

The city of Christchurch shows a progression of ethnically diverse communities. The minority population consists of indigenous Maori people as well as a growing number of Asian and Pacific Islanders. Thus the existing and rather new forming ethnic communities should be fundamentally applied in the development of hazard management planning in Christchurch City. Prior research of people's perceptions of natural hazard risk has proven that people perceive hazards in different ways. Cultural influences can have a major impact on how certain communities prepare and mitigate for natural hazards. Understanding the differences among these groups can help encourage a more holistic approach to managing natural hazard risks. It can also help establish effective risk communication tools that are relevant to communities needs. The purpose of this study is to examine the forces among cross-cultural communities in Christchurch which influence their perceptions of natural hazard risk in Christchurch. Furthermore, the study will determine the geography of multi-cultural communities in Christchurch with the assist of Geographical Information Systems (GIS). This will allow for an opportunity to examine spatial data representing hazards, risks and vulnerability information based on different cultural groups. The September 2010 Christchurch earthquake will be embraced in this study as an opportunity to explore hazard perceptions from a very recent and devastating event for Christchurch, New Zealand. This study will conclude with fostering a better understanding of how cultural systems can influence society's perceptions of natural hazard risk in Christchurch. This will provide a pivot point for communities and emergency management to assess the interplay between relevant social factors and hazards via an examination from a 'perceptual' lens.

Maximizing Participatory Planning in Emergency Management: Implications for professional practice

John Lindsay

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This research will examine how to maximize the potential benefits of applying participatory planning to a range of comprehensive emergency management planning activities. Three main themes will be explored: the role of vulnerability and risk perception in community participation; the application of participatory planning techniques to different planning activities and; the repercussion of adopting a participatory planning approach for professional practice. Each theme will each yield a set of research sub-questions and the resulting conclusions will benefit from this multi-faceted approach. Furthermore, while professional practices in Canada and New Zealand are similar they also reflect unique political and social contexts. Case studies from both countries will therefore be undertaken to determine the degree to which these factors may affect these three themes.

Organisational Resilience and Recovery after the Christchurch Earthquake

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Organisations look after infrastructure, are a fundamental part of the economy, of society and of people's lives. Communities depend on organisations for response and recovery after major events as well as for their day to day needs thereafter. Therefore it is important for organisations to be resilient in order to ensure that the organisation survives and to minimise the disruption caused by disaster to societal routines.

To date, of the research done on the effect of disasters to organisations, most of it has been from the economic perspective of a region or a nation.

This research will examine the impact of disasters to individual organisations; specifically organisational vulnerability to disaster, what the impacts of disaster are, and the factors affecting recovery. For the organisation, apart from dealing with the business interruption that disruptive events might cause, it is also recognising the risks and opportunities that might arise.

However, organisations do not exist independent of their environment. Organisations build networks with and are influenced by customers, suppliers, government regulations and other organisations around them. Consequently, organisations are part of, contribute to and are affected by what is a large, dynamic system. Therefore, there is a need to look into what system behaviours contribute to the recovery of an individual business, a sector and between sectors.

In addition, in the aftermath of a disaster, it is important to understand the impacts of not only the physical damage to an organisation's possessions but also the economic impacts of such an event. Further, it has been seen that the effects of and recovery from disaster are different for different organisations. For that reason, the major factors in the recovery of organisations from disasters will be investigated. Some of the factors that will be considered include: the size of the organisation; the gravity of the effects (direct and indirect) of a major hazard event; the organisation's level of resilience prior to a major event, and the pre-event "state of health" of the organisation.

Due to the networks that are built before and after a major hazard event, it is vital to look at the recovery of organisations as an ever changing, interconnected process.

Some of the aism of this research are to investigate what the factors involved in organisational recovery are after disaster, as well as to examine the system behaviours that contribute to organisational recovery.

Effective management of an unrest crisis at New Zealand volcanoes

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Active volcanoes are located in the North Island of New Zealand; the largest and most unpredictable of these are calderas, such as Taupo, regarded as the most active caldera system in the world. Volcanic unrest consists of seismicity, deformation and changes in the gas and hydrothermal systems, and has been observed more than 14 times in the past 160 years at Taupo to the public's alarm. Unrest has the potential to affect the economy, the tourism industry, infrastructure, the health of the nearby residents and the trust between the community, media, public officials and scientists. No emergency management plans currently exist to mitigate the effects of an unrest event at Taupo caldera.

The Volcanic Alert Level (VAL) system is used by GNS Science to communicate the current state of each volcano to emergency response officials, and must be carefully managed to maintain the public's trust and minimise the number of "false alarms". The decision of at what stage the scientists at GNS Science change the VAL will become more and more difficult as monitoring technology progresses and events are recorded which would not have been noticed in the past.

My primary research question is *how is the Volcanic Alert Level system in New Zealand used effectively during volcanic unrest episodes?* An exploratory, qualitative methods approach will be used with document analysis, focus groups and interview methods employed, and content and thematic analysis utilised.

Behaviour of small debris flows in New Zealand alpine catchments

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Supervisors: Elisabeth Bowman, Tim Davies, Chris Massey

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Debris flows consist of mixtures of soil, rock and water that travel at high speeds down slopes, wreaking havoc on people and infrastructure in their path. Debris flows occur frequently in mountainous areas, including New Zealand, when heavy rainfall saturates loose, unconsolidated debris provided by hillslope erosion, weathering, or anthropogenic processes. Despite their frequency, the public recognition of debris flows is relatively low in New Zealand because of its low population density. In New Zealand, there has been relatively little detailed assessment of debris flows in terms of how large they are, how far they run, what sort of materials are involved, how frequently they occur and how they are triggered. This knowledge is needed in order for risk assessment of these hazards to be carried out. To begin to address this, we have field surveyed 21 debris flow events in small, alpine catchments around the country. The resulting data-set covers a wide-range of climatic conditions and geology. It begins place New Zealand's debris flows in the context of the world-wide state of knowledge, so that simple empirical numerical models can be used for risk assessment and mitigation of these dangerous events.

While these field investigations are useful to understand how New Zealand flows relate to others around the world and suggest reasonable methods of hazard assessment, they are not very useful in understanding the underlying physics of debris flow movement, as many important variables influencing the flow behavior are impossible to measure in the field. To overcome these limitations, a separate study was conducted using a small-scale, experimental debris flow channel housed within a geotechnical centrifuge. The small-scale of the experiment enabled debris flow behavior to be examined in a carefully controlled manner. The centrifuge allowed important processes to be scaled up to more closely model a larger debris flow in the field. In particular, these tests explored the influence of moisture and soil mass on debris flow velocity and travel distance. Sensors placed in the channel enabled the model flow to be tracked before it exited onto the runout area, while a camera was used to provide high speed footage of the flow. The results showed a clear relationships between flow velocity, mass, momentum, slope, moisture and travel distance which may be eventually used to give insight to debris flow mechanics and generate better models for risk mitigation.