## Chapter 16

# Developing effective communication tools for volcanic hazards in New Zealand, using social science

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## 16.1 Background

Social science plays an increasing and valuable role in volcanic Disaster Risk Management (DRM); social science research methods are now used globally to investigate and improve the links amongst volcanology, emergency mangement and community resilience to volcanic hazards. The biennial IAVCEI Cities on Volcanoes Conferences, each hosted by an international city at risk from volcanic hazards, held its eighth meeting in Yogyakarta (Indonesia) in September 2014. These meetings attract large attendances of social and physical scientists as well as emergency managers and DRM practitioners. By incorporating social science methodologies, information derived from volcano monitoring and data interpretation can be used in the most effective way possible to reduce the risk of volcanic hazards to society.

A range of New Zealand researchers at universities, and the government earth science research institute GNS Science, have been conducting applied social research focussed around natural hazards for nearly 20 years, spearheaded by studies of the impacts of the 1995/96 eruptions of Ruapehu volcano. In 2006 the national Joint Centre for Disaster Research was established, a joint venture between Massey University School of Psychology and GNS Science. It includes researchers from other universities and agencies and undertakes multi-disciplinary applied teaching and research aimed at gaining a better understanding of the impacts of disasters on communities, improving the way society manages risk, and enhancing community preparedness, response and recovery from the consequences of hazard events. Researchers also focus on the effective communication of likelihoods for volcanic eruption forecasts (Doyle et al., 2014). Three projects are highlighted here as examples of volcanic hazard focussed research within this collaborative national social science framework.

## 16.2 Development of a revised Volcanic Alert Level system

The communication of scientific information to stakeholders is a critical component of an effective Volcano Early Warning System. Volcanic Alert Level (VAL) systems are used in many countries as a tool to communicate complex volcanic information in a simple form, from which response decisions can be made. Communication tools such as these are required to meet the needs of a wide range of stakeholders, including central government, emergency managers, the aviation industry, media and the public. They are also required to be usable by the scientists who determine the levels based on volcano observations and interpretation of complex monitoring data.

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A recent research project by Potter et al. (2014) involved the exploration of New Zealand's 20-year old VAL system. For the first time globally, a new VAL system was developed based on a robust qualitative ethnographic methodology, which is commonly used in social science research (e.g. Patton (2002)). The research involved interviews of scientists and stakeholders, document analysis, and observations of scientists over three years at GNS Science as they set the VAL during multiple unrest and eruption crises. The data resulting from the interviews underwent thematic analysis, which involves grouping comments made by participants into themes. The findings were triangulated against the document analysis and observation data to produce a draft new VAL system. The draft system then went through multiple iterations with stakeholders and scientists, until a final version acceptable to all interested parties was formed.

The new VAL system, which is presented in Figure 16.1, was integrated into the Ministry of Civil Defence and Emergency Management's Guide to the National Civil Defence and Emergency Management plan in 2014. For more information on New Zealand's VAL system, visit www.geonet.org.nz/volcano. The methodology utilised in this trans-disciplinary research is applicable worldwide, and potentially could be used to develop warning systems for other hazards.

**New Zealand Volcanic Alert Level System**

| | Volcanic Alert Level | Volcanic Activity | Most Likely Hazards |
|---|---|---|---|
| Eruption | 5 | Major volcanic eruption | Eruption hazards on and beyond volcano* |
| Eruption | 4 | Moderate volcanic eruption | Eruption hazards on and near volcano* |
| Eruption | 3 | Minor volcanic eruption | Eruption hazards near vent* |
| Unrest | 2 | Moderate to heightened volcanic unrest | Volcanic unrest hazards, potential for eruption hazards |
| Unrest | 1 | Minor volcanic unrest | Volcanic unrest hazards |
| | 0 | No volcanic unrest | Volcanic environment hazards |

**An eruption may occur at any level, and levels may not move in sequence as activity can change rapidly.**

**Eruption hazards** depend on the volcano and eruption style, and may include explosions, ballistics (flying rocks), pyroclastic density currents (fast moving hot ash clouds), lava flows, lava domes, landslides, ash, volcanic gases, lightning, lahars (mudflows), tsunami, and/or earthquakes.

**Volcanic unrest hazards** occur on and near the volcano, and may include steam eruptions, volcanic gases, earthquakes, landslides, uplift, subsidence, changes to hot springs, and/or lahars (mudflows).

**Volcanic environment hazards** may include hydrothermal activity, earthquakes, landslides, volcanic gases, and/or lahars (mudflows).

***Ash, lava flow, and lahar (mudflow) hazards may impact areas distant from the volcano.**

This system applies to all of New Zealand's volcanoes. The Volcanic Alert Level is set by GNS Science, based on the level of volcanic activity. For more information, see geonet.org.nz/volcano for alert levels and current volcanic activity, gns.cri.nz/volcano for volcanic hazards, and getthru.govt.nz for what to do before, during and after volcanic activity. Version 3.0, 2014.

*Figure 16.1 New Zealand's new Volcanic Alert Level system. The most up-to-date system is always accessible via www.geonet.org.nz/volcano.*

## 16.3 Lahar hazard mitigation at Mt Ruapehu

Research into public awareness of, and response to, lahar warnings at one of New Zealand's major ski areas situated on the active Ruapehu volcano has been conducted annually for over a decade. Lahars have travelled through the ski area in multiple eruptions in the last 50 years (e.g., Figure 16.2 image). Visitors are required to evacuate from lahar-prone valleys immediatly following a siren and voice announcement automatically triggered by eruption sensors. They have as little as two minutes to move to safety and individual and group behaviour amongst visitors and ski area staff must be immediate, decisive and correct. Social research includes the following:

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(a) Annual assessment of public and staff responses to simulated events, including truly 'blind' exercises where both staff and the public are un-aware that the warning is an exercise. This has full support from the tourism company operating the ski area, and the Department of Conservation with primary risk management responsibility for the world heritage status national park within which Ruapehu sits.
(b) Awareness surveys of volcanic hazards, recall of education material and messages, and correct actions to take in a warning.
(c) Organisational psychology research into staff behaviour and training needs analysis for specific roles.
(d) Analysis of potential education media and contact points to improve public response to warnings.
(e) Surveys of the demographics of the public who continue to not respond to warnings during exercises, to further direct educational resources.

All of this has indicated potential actions that could be taken to improve future responses, such as increasing ski area staff training (Christianson, 2006) and improving hazard signage (Leonard et al., 2008). It has also lead to technical improvements in hardware performance, audibility and messaging.

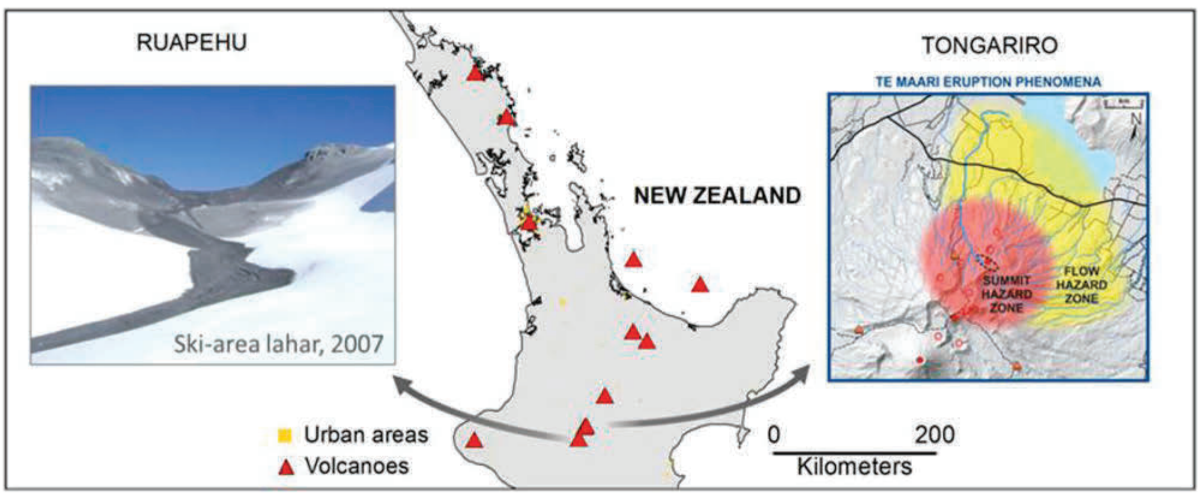


*Figure 16.2 Volcanoes in New Zealand, including a photo of a ski-area lahar at Ruapehu, and the hazard map for Tongariro. The comprehensive Tongariro hazard map can be found at http://gns.cri.nz/Home/Learning/Science-Topics/Volcanoes/Eruption-What-to-do/Hazard-maps.*

By repeating this research annually and tracking perceptions of visitors through time in response to real events, the communication tools continue to be improved. Surveys demonstrate that tourists appreciate that the hazard is monitored, warned for and that education materials are visible – leading to strong industry support. A design and communications research project is currently underway to direct new education initiatives to the specific demographics of people seen not responding to warnings.

## 16.4 Tongariro hazard maps

Social research into the perceptions of volcanic hazards and education materials supported the creation of a new volcanic crisis hazard map for eruptions at Mt. Tongariro in 2012 (Figure 16.2; Leonard et al. (2014)). The area impacted by the eruptions included a section of the popular

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Tongariro Alpine Crossing walking track, which has nearly 100,000 people passing annually within less than 3 km of the 2012 vent. Requirements of tourists, concessionaires and local residents were considered alongside scientific modelling and geological information, as well as core messages from emergency management agencies, to produce an effective collaborative communication product.

The crisis map had to accommodate several complex issues:

(i) background hazard maps are used across the many potentially active vents during non-eruptive periods, but these may not match crisis hazard maps and scenarios with very elevated probability compared to the background;

(ii) the scientists' need for conservatism while constraining hazards that were initially in conflict with more probable short-term hazards in time-sensitive situations;

(iii) hazards tend to grade away spatially and should ideally be shown in a gradual probabilistically defined way, but maps need to be simple;

(iv) messaging covers several severe hazards and actions, needing to be a balance between simplicity to achieve high awareness and not clutter the map, but enough detail to be meaningful; and

(v) the visual representation of elements (i) through (iv) on a single piece of paper that can be quickly and correctly comprehended.

Ongoing social research results from Tongariro (Coomer and Leonard, 2005) and Ruapehu were applied to help guide an optimum solution in the face of these issues. International research, especially around the effective presentation of hazard maps (Haynes et al., 2007), and the development of trust amongst scientists, emergency managers and the public (e.g. Barclay et al. (2008), Johnston et al. (1999), Paton et al. (2008)) was also applied.

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Tongariro background and crisis hazard map latest versions can be found in full at: gns.cri.nz/Home/Learning/Science-Topics/Volcanoes/Eruption-What-to-do/Hazard-maps

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