Volcanic hazard awareness in the tourism sector in Mammoth Lakes, California, USA

Grant Kaye
David Johnston
Kirsten Finnis
Douglas Paton

GNS Science Report 2008/35
October 2008

GNS SCIENCE
TE PŪ AO

BIBLIOGRAPHIC REFERENCE

Kaye, G.; Finnis, K.K.; Johnston, D.M.; Paton, D. 2008. Volcanic hazard awareness in the tourism sector in Mammoth lakes, California, USA.
GNS Science Report 2008/35 13 p.

G. Kaye, Natural Hazard Research Centre, University of Canterbury, PB 4800, Christchurch
K. K. Finnis, Joint Centre for Disaster Research, Massey University, PO Box 756, Wellington
D. M. Johnston, GNS Science, PO Box 30368, Lower Hutt / Joint Centre for Disaster Research, Massey University, PO Box 756, Wellington
D. Paton, University of Tasmania, Launceton, Australia

ISSN 1177-2425
ISBN 978-0-478-19645-0

CONTENTS

FIGURES

TABLES

ABSTRACT

Mammoth Lakes, California, USA, is located in an area prone to many hazardous natural events, including wildfires, snow avalanches, earthquakes, extreme weather, and volcanic eruptions. Volcanic hazards threaten Mammoth Lakes due to the town's proximity to the active Long Valley volcanic system, which includes the Long Valley Caldera and the Mammoth Mountain stratovolcano, on which the Mammoth ski area is situated. Because of the importance of tourism to the area, levels of business preparedness will affect social and economic resilience in the event of a volcanic crisis. To examine this, a face-to-face survey of business owners and staff in Mammoth Lakes was undertaken in January 2006 to gauge awareness levels of the business and tourism sectors to volcanic hazards. The survey results indicated only moderate awareness levels of natural (including volcanic) hazards and limited staff training, which suggests a need for ongoing hazard-specific employer and employee education. This case study provides an insight into the level of awareness and response training on the part of those who would play a critical role in any response to a future volcanic emergency in the Mammoth Lakes area. Suggestions on how to improve preparedness and underpin effective emergency management services in a busy destination resort area with high numbers of seasonal visitors are also included.

KEYWORDS

Mammoth Lakes, Long Valley Caldera, volcanic hazard awareness, preparedness, staff training, business survey

1.0 INTRODUCTION

Mammoth Lakes is located at the intersection of the eastern limit of the Sierra Nevada mountains and the western edge of the tectonically active Basin and Range physiographic province in Mono County, California (Hill et al., 1985; Figure 1). Mammoth Mountain is an active stratovolcano situated on the physiographic rim of the Long Valley Caldera (broken red line, Figure 1). The town spreads over an area of ~65 km^2 and has a permanent resident population of ~7,000. In the last few years, the ski area built on and around Mammoth Mountain has become the most popular ski resort destination in the United States. Over 1.5 million skier visits were recorded in 2006 (Mammoth Mountain Guest Profile Projections, 2006). During the peak of the winter ski season, up to 20,000 people can be present in the daytime with slightly lower numbers at night in any one of the town's nearly 4,600 seasonal, recreational, or occasional housing units (Mammoth Mountain Guest Profile Projections, 2006). The economy of Mammoth Lakes is highly dependent on the influx of tourists.

In the event of a natural disaster in Mammoth Lakes such as a large earthquake or volcanic eruption, a major facet of the tourist-based economy's disaster resilience will be the level of readiness of local businesses (e.g. Chang et al., 2002), particularly their level of business recovery and continuity planning. Furthermore, businesses relying on tourism face issues of managing a clientele who are unfamiliar with the area. This makes developing comprehensive evacuation plans an integral part of disaster-response planning for businesses.

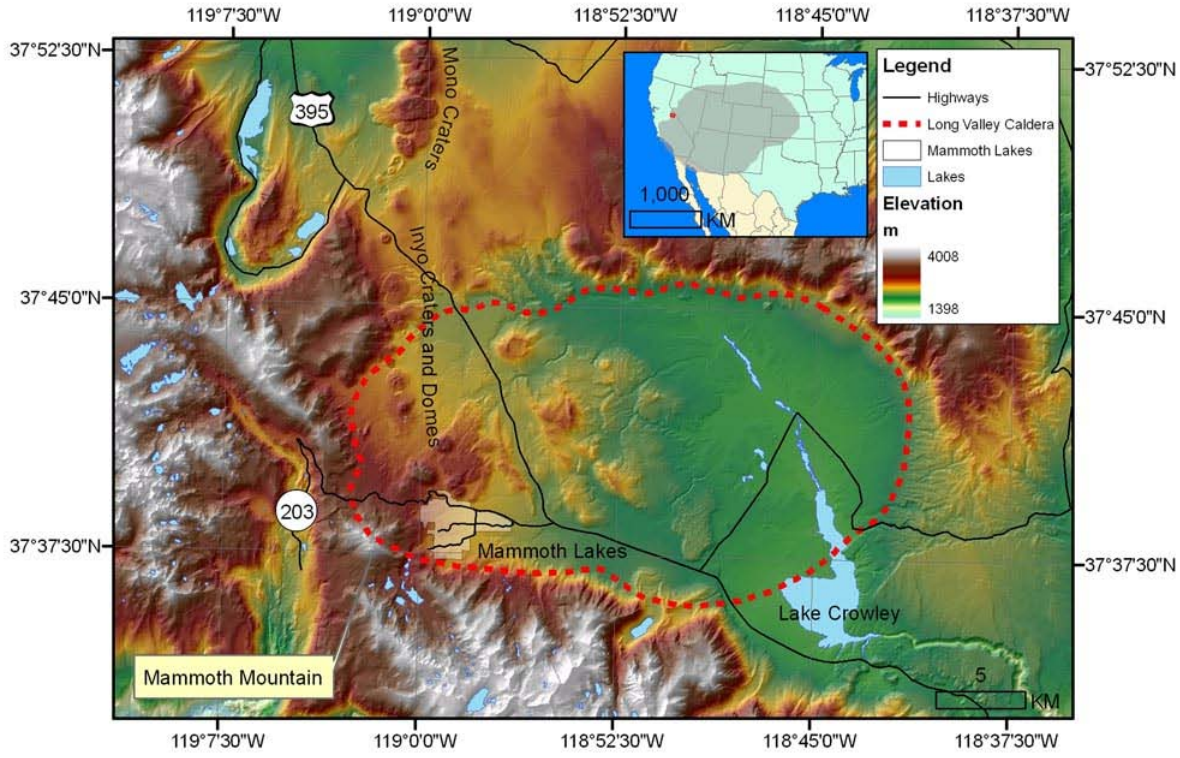

Figure 1 Physiographic and location map of Mammoth Lakes (tan area left of centre). The inset figure shows the distribution of ash from the Bishop Tuff eruption, after Izelt et al., 1970.

2.0 REGIONAL SETTING

A range of natural hazards threaten the Mammoth Lakes area. The heavily forested and mountainous area is subject to seasonal wildfire and avalanche dangers, as well as heavy snowfall events and the potential for volcanic eruptions (Hill et al., 1997). The region has seen frequent volcanic activity over the last three million years, varying in duration, style, and magnitude. Mammoth Lakes is situated directly north of the southwestern edge of the roughly oval-shaped Long Valley caldera (Figure 1, broken red line), which exploded catastrophically around 760,000 years ago in a paroxysmal eruption that spread ash over much of the western United States (inset, Figure 1; after Izelt et al., 1970).

2.1 Recent volcanic activity

Subsequent volcanic activity has affected much smaller areas; the two most recent eruptions in the area took place at nearby Mono Craters in the 1800s, and at the Inyo chain of craters about 650 years ago (Miller, 1985). Volcanic activity continues through the present day at the Long Valley Caldera and beneath Mammoth Mountain in the form of earthquakes and upper-crustal deformation (Hill and Prejean, 2005). Although no magmatic eruptions have occurred in the last 200 years, magma is still thought to underlie the main Long Valley caldera floor as well as Mammoth Mountain, manifested as ongoing seismic activity (e.g. Hill et al., 1985), surface degassing (e.g. Farrar et al., 1995), and deformation (e.g. Dixon et al., 1997).

Earthquake swarms in 1978 and 1980 caused a great deal of concern within the local population, raising public alarm and resulting in threats of harm made to volcano monitoring scientists (Mader and Blair, 1987). In 1982, prior to the release of the US Geological Survey's (USGS) official notice concerning volcanic unrest at Long Valley, the Los Angeles Times learned of the impending news and published a story about potential volcanic activity in the area. The newspaper article was the first that local population and authorities had heard of the official USGS notice; the lack of consultation angered many local residents and officials. Mass cancellation of tourist bookings at Mammoth Lakes followed the initial newspaper and radio reports of the possibility of an eruption in the summer of 1982 (Mader & Blair 1987). By late 1984, visitor numbers had returned to pre-warning levels (Mader & Blair 1987).

In 1989, a swarm of three small earthquakes occurred beneath Mammoth Mountain (Hill et al., 1990) as magma percolated into the shallow crust beneath the volcano (Hill, 1996). The following year, ~ 3.6 km^2 of trees around Mammoth Mountain (~3.6) began to "mysteriously" die as a result of high levels of carbon dioxide gas being released from the cooling magma into the soil of the volcano (Farrar et al., 1995).

The degassing that continues today from fumaroles on Mammoth Mountain constitutes one of the most deadly hazards in the area, as rising magmatic fumes expelled from the fumarole can become trapped beneath the heavy blanket of snow which coats Mammoth Mountain in the wintertime. These hot gases melt upward into the snowpack, but do not always reach the surface, causing a collapse hazard to anyone venturing onto the snow above the vent (i.e. snow collapsing into holes melted from below). The Mammoth Mountain ski patrol regularly cordons off the area around the fumaroles to prevent skiers from falling in following heavy

accumulations of new snow. Despite this, on 6 April 2006, three Mammoth ski patrollers lost their lives while trying to barricade off an area of weak snow over one of the volcano's fumaroles (Shirk, 2006). Seven others were hospitalized from injuries sustained while trying to rescue their fallen colleagues.

2.2 Potential for future eruptions

Although less likely than fumarole-related deaths, destructive volcanic hazards could occur in Mammoth Lakes as a result of a magmatic eruption at the Long valley caldera, Mammoth Mountain, or the Mono/Inyo craters (Hill et al., 1997; Miller et al., 1982). The probability for an eruption in any given year is ~1 in 100 (Hill et al., 1997). While a basaltic eruption could lead to lava flows threatening property, a rhyolitic eruption could result in ash-column collapse, which would generate devastating pyroclastic flows over widespread areas (Hill et al., 1991; Miller et al., 1982); both styles of eruption are possible (Hill et al., 1997). Possible hazards from magmatic eruptions include tephra falls that would impact the town and surrounding areas, as well as pyroclastic block-and-ash flows that would emanate from a collapse of freshly extruded lava domes during such eruptions (Kaye et al., 2008, in press); both of these have the potential to significantly impact Mammoth Lakes. If such flows were to occur in wintertime, they would have the potential to melt snowpack and generate destructive lahars (Pierson and Waitt, 1996). This would also have a significant effect on the economic well-being of the area, at least over the short term. The importance of winter tourism (e.g., winter sports) for the local economy makes levels of business preparedness an important indicator of the social and economic resilience of Mammoth Lakes.

3.0 MATERIALS AND METHODS

3.1 Hazard Awareness Survey

Because of the continuing risk of volcanic hazards in and around Mammoth Lakes, a volcanic hazards awareness survey of 91 business employees in Mammoth Lakes was undertaken in January 2006 to establish present awareness levels. The design of the survey was similar in composition and execution to surveys undertaken in 2001 to measure tsunami hazard awareness in the tourism sector along coastal Washington, USA (Johnston et al., 2005; 2007).

A face-to-face, five-minute survey was conducted with 91 business staff and owners at 91 places of business in January 2006. All businesses in Mammoth Lakes open during the daytime survey period were targeted equally; the response rate depended upon staff willingness to participate, and was very high. Interview questions focused on employees' understanding of natural hazards in the Mammoth Lakes area, level of employee training for emergencies, and sources from which employees had received hazard information (if any).

The survey responses were entered into the SPSS software package for data analysis.

4.0 RESULTS

Acknowledging natural hazard risk is pivotal to taking action to mitigate volcanic hazard consequences. Despite efforts to inform the community (see below), only 57% of businesses acknowledged the potential threat from volcanic hazards. Of those that did, this did not necessarily translate into preparedness. Only 24% of businesses reported receiving information and, when summing the 'No' and 'Not Sure' responses, some 69% reported that they had not undertaken any business preparedness measures. Of those that had made preparations (31%), most were in the form of fire insurance. Other infrequently reported preparations included stockpiling food and water, preparing emergency kits, and making emergency plans such as designating evacuation routes, identifying predetermined meeting places, and securing household items.

Natural hazards awareness among businesses in Mammoth Lakes overall was moderate, and specific awareness of volcanic hazards was low to moderate (Table 1). Of all respondents that reported having received information about natural hazards directly pertaining to Mammoth Lakes or Mammoth Mountain, most noted the USGS as a primary source of information regarding volcanic hazards. Additional reported sources of information included newspapers, brochures, signs, radio and television, along with personal experience and general knowledge. Almost all employees surveyed regarded proper warning of hazardous weather events as the most pressing issue with respect to the continuity of their businesses' operations. Notwithstanding, only 37% of respondents reported having received information on volcanic hazards. Overall, only 10% of the total sample (i.e., 36% of 22 respondents) of businesses who reported receiving information found this information useful. The total number of employees trained for emergencies was low (34%). Of these, the majority had been trained in first aid, with the next highest number having received training in fire emergencies. Ten percent of those who had received training reported having been trained in emergency evacuation procedures, and 19% in safe earthquake response behavior. This translates into only 4% (of 91 businesses) having evacuation planning. This is a significant finding in the context of businesses that may have to cater for the needs of tourists during a crisis who are unfamiliar with the area (see above).

Table 1 Results of Mammoth Lakes business hazard awareness survey.

MAMMOTH LAKES BUSINESS SURVEY QUESTIONS

1. What natural hazards have the potential to significantly impact your business?

Hazard	**%**
Earthquake	55
Weather	48
Volcano	46
Fire	14
Avalanche	9
Don't know	8
Other	4
None	4

2. Have you received any information about natural hazards specific to Mammoth Lakes?

Yes=30%, n=27

Hazard	**%**
Earthquake	22
Weather	4
Volcano	37
Fire	0
Avalanche	0
Don't know	0
Other	11
None	0

3. What measures have you or your business undertaken to prepare for hazard events?

Preparations	**%**
None	55
Some	31
Not sure	14

4. Have you received training for dealing with emergencies?

Yes=34%, n=31

If yes, what?	**%**
First Aid	36
Fire	29
Other	20
Earthquake	19
Evacuation	10

5. Have you received any information about the volcanic hazards?

Yes=24%, n=22

Was it Useful?	**%**
Not sure	48
Yes	36
No	14

6. Do you believe that volcanic hazards pose a threat to this community?

Answer	**%**
Yes	57
No	20
Maybe	20
Don't know	3

7. Do you believe that authorities are doing enough to prepare for future volcanic activity?

Answer	**%**
No	48
Yes	28
Not sure	24

Of the total businesses surveyed, only half believed that the authorities were doing enough to prepare for future volcanic eruptions. While some respondents offered the opinion that there was "nothing more authorities could do," others were receptive to the idea of obtaining additional training from either authorities or their employers. No business surveyed reported any organized employee training for natural hazards.

5.0 DISCUSSION

It has been well documented that those in or around tourism-based towns with large transient populations will seek out "official" local people (e.g. employees of nearby businesses as well as public authorities) for information and appropriate response actions when an infrequent hazard event occurs or is imminent (e.g. Drabek, 2000). Nonetheless, staff training for non-routine emergency response is a commonly neglected activity in the tourism sector (Ritchie 2004; Johnston et al. 2007). This is complicated by the high levels of staff turnover experienced annually and even seasonally in many centres with a tourism-based economy (Johnston et. al 2007, Leonard et. al. 2008). It is not surprising therefore, to learn that despite the strategies developed subsequent to the 1982 incident to prepare the Mammoth Lakes community for a future volcanic eruption (e.g. hazard assessments, response plans, community talks and table top exercises, Hill et al., 1991; open file reports such as Hill et al., 1997; USGS Long Valley Observatory website http://lvo.wr.usgs.gov;) volcanic hazard awareness levels among tourism and business employees remains low to moderate. The onus of hazard education must be shifted from the employees to the employers.

It is important to understand why levels of preparedness remain low despite the attention the authorities have given to providing information and to identify how to progress this issue to in order to encourage sustained business preparedness. With regard to the former, one reason is likely to lie with the way in which the 1982 event was handled. Lack of consultation and disclosing a high risk event as a fait accompli is likely to have had the effect of creating distrust in formal authorities and thus a reduction in business receptivity to subsequent information (Paton, 2008). While additional work will be required to confirm whether this is an influence, this possibility suggests that the authorities need to attend as much to developing the quality of their relationship with business as they do to making information available (Paton, 2008). This will provide a context more conducive to facilitating information uptake and business training and planning.

The results of this survey indicate that improving employee hazard awareness via some regular training programs would increase resilience across the tourism sector. A possible and logical first step would be to conduct a training needs analysis (Paton et al. 1999, Paton and Jackson 2002), to determine what precisely is needed to increase disaster response capabilities and, as a result, increase the potential for developing resilience in the tourism sector. Any analysis used to design staff training would focus at a minimum on evaluating:

- Understanding of hazards, vulnerability, and risk;
- State of emergency planning, if any;
- Levels of individual and organizational strengths and weaknesses with regard to specific training;
- Barriers to implementing mitigation; and
- Ways to ameliorate the negative impact of false alarms.

Another interesting outcome was finding a discrepancy in responsibility for action. While some 31% of businesses described having undertaken some preparation, in comparison (when combining the 'No' and 'Not Sure' responses) 72% believed the authorities should be doing more. This is consistent with other hazard research (e.g., Paton and Wright, 2008) in showing a transfer of responsibility onto 'the authorities,' which underlines a need for better engagement between authorities and business if they are to facilitate business planning and preparedness.

One avenue available to efficiently incorporate the results of a training needs analysis is existing fire emergency training, which requires mandatory education by employers for all new employees on such matters as effective exits and evacuation procedures (OSHA 2004). As suggested in Johnston et al. (2007) this mandatory training presents an excellent opportunity to insert volcanic hazard information and suggested response actions should a volcanic crisis develop. See Paton and Flin et al. (1999) for information on this issue. It is also important that businesses look beyond the development of a capability for effective response to the immediate demands of a volcanic crisis and consider their business continuity needs. Further information on how the latter can be accomplished is available in Paton and Hill (2006).

6.0 CONCLUSIONS

Volcanic hazards in an eruption are a part of one of the most demanding situations volcanological and emergency management services have to respond to (Johnston et al. 2002). If handled poorly, significant social, economic and political problems could result, even if an actual eruption does not occur (Johnston et al., 2002; Bernknopf et al., 1990). The town of Mammoth Lakes has a tourism-based economy, a high transient population, and a dense hazardscape due in part to its close proximity to one of the most prolific volcanic centres in North America. Despite this potentially dangerous combination, surveyed businesses in the area exhibited a low to moderate level of volcanic hazards awareness. Over half of those surveyed do not think authorities are doing enough to prepare for future volcanic activity, while almost two thirds of surveyed businesses think that volcanic hazards pose a threat to the community.

While the chances of an eruption in any given year remain moderate (1 in 100; Hill et al., 1997), the consequences of an eruption to the economy, infrastructure, and population of the region make this threat one authorities ignore at their peril, and one for which effective response requires a proactive approach on the part of business and authorities alike. Any period of quiescence provides the optimum opportunity to develop a better understanding in the community and the tourism sector of the volcanic risk phenomena (Leonard et al. 2008). It is also the best time to establish educational and training programs, and to develop coordinated contingency plans. The insertion of specific volcanic hazard awareness into existing staff emergency training also has the potential to improve the overall level of volcanic hazard understanding and response in Mammoth Lakes. It is evident from the data presented here that increasing levels of business capability will require authorities to more actively engage with businesses in the area if they are to facilitate sustained volcanic hazard preparedness.

7.0 ACKNOWLEDGEMENTS

The authors would first like to thank Ms. Tracey Fuller of Mammoth Lakes for housing us during the survey in 2006. Dr. Graham Leonard of GNS Science and Dr. Andrew Sanders of the Wellington School of Medicine assisted us with the survey in Mammoth Lakes, and the authors are grateful for their help. The first author was supported by a University of Canterbury Doctoral Research Scholarship and an Education New Zealand International Doctoral Research Scholarship.

8.0 REFERENCES

Bernknopf, R.L., Brookshire, D.S., and Thayer, M.A. 1990. Earthquake and volcano hazard notices: an economic evaluation of changes in risk perception. Journal of Environmental Economics and Management. 18: 35-49.

Chang S.E., and Falit-Baltimore, A., 2002. Disaster Vulnerability of businesses in the 2001 Nisqually Earthquake, Environmental Hazards. 4: 59-71.

Dixon, T. H., A. Mao, M. Bursik, M. Heflin, J. Langbein, R. Stein, and F. Webb, 1997. Continuous monitoring of surface deformation at Long Valley Caldera, California, with GPS, Journal of Geophysical Research. 102(B6): 12,017–12,034.

Drabeck, T. 2000, Pattern Differences in Disaster-Induced Employee Evacuations. International Journal of Mass Emergencies and Disasters. 18 (2): 289-315.

Farrar, C.D., M.L. Sorey, W.C. Evans, J.F. Howle, B.D. Kerr B.M. Kennedy, C.-Y. King, and J.R. Southon, 1995, Forest-killing diffuse CO2 emission at Mammoth Mountain as a sign of magmatic unrest. Nature. 336: 675-678.

Hill, D., Ellsworth, W., Johnston, M., Langbein, J., Oppenheimer, D., Pitt, A., Reasenberg, P., Sorey, M., and McNutt, S., 1990. The 1989 earthquake swarm beneath Mammoth Mountain, California: An initial look at the 4 May through 30 September activity. Bulletin of the Seismological Society of America; April 1990. 80 (2): 325-339.

Hill, DP. 1996. Earthquakes and carbon dioxide beneath Mammoth Mountain. California: Seismological Research Letters. 67: 8-15.

Hill, D.P., R.A. Bailey, and A.S. Ryall, 1985, Active tectonic and magmatic processes beneath Long Valley caldera, eastern California: a summary. Journal of Geophysical Research. 90: 11,111-11,120.

Hill, D.P., M.J.S. Johnston, J.O. Langbein, S.R. McNutt, C.D. Miller, C.E. Mortensen, A.M. Pitt, and S. Rojstaczer, 1991, Response plans for volcanic hazards in the Long Valley caldera and Mono Craters area, California. U.S. Geological Survey Open File Report 91-270, 64 p.

Hill, D.P., Bailey, R.A., Miller, C.D., Hendley, J.W., II, and Stauffer, P.H., 1997, Future eruptions in California's Long Valley area; what's likely?: U.S. Geological Survey Fact Sheet 97-73.

Hill, D. P. & Prejean, S. 2005. Volcanic unrest beneath Mammoth Mountain, California. Journal of Volcanology and Geothermal Research. 146: 257–283.

Izelt et al., 1970, The Bishop ash bed, a Pleistocene marker bed in the western United States. Quaternary Research. 1: 121-132.

Johnston, D., Paton, D., Crawford, G. L., Ronan, K., Houghton, B., Bürgelt, P. 2005. Measuring tsunami preparedness in Coastal Washington, United States. Natural Hazards 35(1): 173 – 184.

Johnston, D.M., Becker, J.S., Gregg, C., Houghton, B.F., Paton, D., Leonard, G.S., and Garside, R., 2007. Developing warning and disaster response capacity in the tourism sector in coastal Washington, USA. Disaster prevention and management, 16 (2): 210-216.

Johnston, D., Scott B., Houghton, B., Paton, D., Dowrick, D., Villamor, P., Savage, J. 2002. Social and economic consequences of historic caldera unrest at the Taupo volcano, New Zealand and implications for managing future episodes of unrest. Bulletin of the New Zealand Society of Earthquake Engineering. 35: 215-230.

Kaye, G.D., Cole, J.W., King, A., Johnston, D. 2008 in press. Comparison of pyroclastic density current hazard risk to critical infrastructure in Mammoth Lakes, California, USA from a new Inyo craters rhyolite dike eruption versus a dacitic dome eruption on Mammoth Mountain, Natural Hazards.

Leonard, G.S., Johnston, D.M., Paton, D., Christianson, A., Becker, J., Keys, H. (in press). Developing an effective early warning system: ongoing warning system development, exercising and social research at Ruapehu volcano, New Zealand. Journal of Volcanology and Geothermal Research.

Mader, G.G., and Blair, M.L. (1987), Living with a Volcanic Threat: response to volcanic hazards, Long Valley, California. Portola Valley, California: William Sprangle, 105 p.

Mammoth Mountain Guest Profile Projections, Mammoth Ski Corporation, 2006

Miller, C. D., Crandell, D. R. Mullineaux, D. R. Hoblitt, R. P. & Bailey, R. A. 1982. Potential volcanic hazards in the Long Valley Mono Lake area, east central California and southwestern Nevada — a preliminary assessment, US Geological Survey Circular, 877.

Miller, C. D. 1985. Holocene eruptions at the Inyo volcanic chain, California; implications for possible eruptions in Long Valley Caldera. Geology. 13: 14–17.

OSHA Principal Emergency Response and Preparedness Requirements and Guidance, 312-064, 2004. <http://www.osha.gov/Publications/osha3122.html>, accessed January 29th, 2008.

Paton, D. 2008. Risk communication and natural hazard mitigation: How trust influences its effectiveness. International Journal of Global Environmental Issues, Vol. 8, Nos. 1/2, pp. 2-16.

Paton, D. & Wright, L 2008. Preparing for Bushfires: The public education challenges facing fire agencies. In J. Handmer & K. Haynes (Eds) Community Bushfire Safety. Canberra: CSIRO Publishing. Paton, D., and Flin, R., 1999. Disaster stress: an emergency management perspective Disaster Prevention and Management. 8(4): 261-267.

Paton, D., Flin, R. 1999. Disaster stress: an emergency management perspective. Disaster Prevention and Management, Vol. 8 pp.261-7.

Paton, D., and Hill, R., 2006. Managing company risk and resilience through business

continuity management. In Disaster Resilience: An Integrated Approach. Springfield, Illinois, Charles C. Thomas.

Paton, D., Johnston, D., Houghton, B., Flin, R., Ronan, K., & Scott, B. (1999). Managing Natural Hazard Consequences: Planning for Information Management and Decision Making. Journal of the American Society of Professional Emergency Planners. 6: 37-47.

Paton, D., and Jackson, D., 2002. Developing disaster management capability: an assessment centre approach. Disaster Prevention and Management. 11 (2): 115 – 122.

Pierson, T., and Waitt, R. 1996. Dome-collapse rockslide and multiple sediment-water flows generated by a small explosive eruption on February, 1983. In Consequences of hot rock/snowpack interactions at Mt. St. Helens: USGS OFR 96/179.

Ritchie, B. 2004. Chaos, crisis, and disaster: A strategic approach to crisis management in the tourism industry. Tourism Management. 25: 669–683.

Shirk, J., 2006. Mammoth Ski Patrol Tragedy, Mammoth Local newspaper.

United States Census, 2000. US Department of Commerce, Bureau of the Census.

www.gns.cri.nz

Principal Location

1 Fairway Drive
Avalon
PO Box 30368
Lower Hutt
New Zealand
T +64-4-570 1444
F +64-4-570 4600

Other Locations

Dunedin Research Centre
764 Cumberland Street
Private Bag 1930
Dunedin
New Zealand
T +64-3-477 4050
F +64-3-477 5232

Wairakei Research Centre
114 Karetoto Road
Wairakei
Private Bag 2000, Taupo
New Zealand
T +64-7-374 8211
F +64-7-374 8199

National Isotope Centre
30 Gracefield Road
PO Box 31312
Lower Hutt
New Zealand
T +64-4-570 1444
F +64-4-570 4657