Natural hazard monitoring in New Zealand: Implications for Tourist Safety

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New Zealand is a young, geologically active country, which is no stranger to spectacular volcanism and frequent earthquakes. Over the period since European settlement (post 1840), seventeen significant earthquakes (magnitude > 7) have resulted in several hundred deaths. Active volcanism in the Taupo Volcanic Zone (TVZ, figure 1) has taken place for c. 10 million years, with the last episode on Mt Ruapehu in the mid-1990s. With visitor numbers to New Zealand growing rapidly, the potential for disruption and damage to the tourism industry from seismic or volcanic activity continues to increase.

Mt Ruapehu erupting in September 1995, with an ash cloud depositing material across ski areas and as far as 250 km from the volcano (source: D. Johnston).

International visitors to New Zealand are attracted by images of a scenic and diverse natural landscape, which has been marketed globally as "100% Pure New Zealand". As a result, the tourism industry in New Zealand over the past two decades has shown remarkable growth, and is now the country's largest export industry, earning $8.1 billion annually, and responsible for one in every ten jobs (Tourism New Zealand 2007). Since 1999, total visitor arrivals to New Zealand have grown by 48%, with forecast continued growth of 4.7% annually (Tourism New Zealand 2007). Visitor flows for short stay international tourists highlight a circuit which takes in the jewels of the New Zealand tourism industry; namely Auckland, Rotorua, Queenstown and Milford Sound. These visitor destinations are inherently hazardous environments, where active volcanism has occurred within the last decade, and where large devastating earthquakes are considered by seismologists to be overdue.

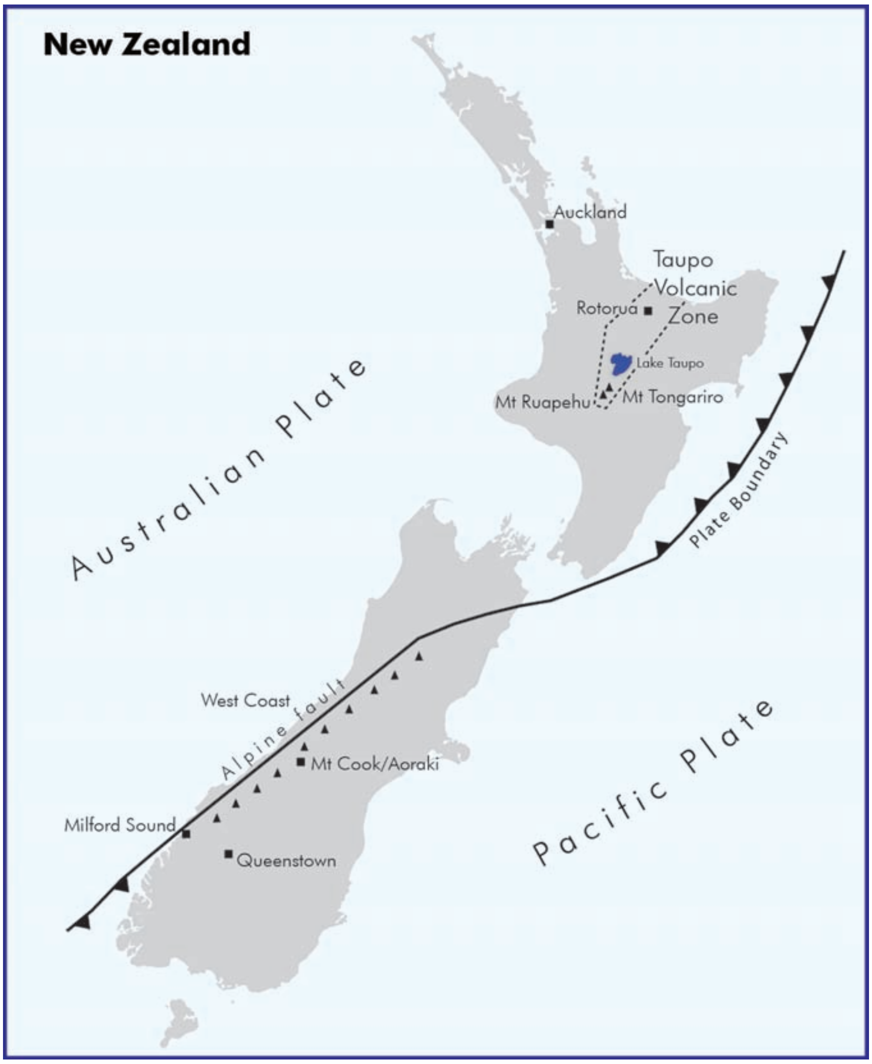
This paper describes two case studies to illustrate natural hazard management in New Zealand, and the potential impact of hazard events on the tourism industry. Firstly, Mt Ruapehu in the central North Island, which erupted most recently in 1996, causing significant financial and physical disruption to the tourism (ski and aviation) economy in the area. Second, the alpine destinations of the South Island, which lie close to the Alpine fault, a 500 kilometre geological feature defining the position of the plate boundary in the South Island (figure 1). Paleoseismic evidence suggests this fault produces large (magnitude 7.8 – 8) earthquakes every 100-300 years, with the last known event occuring in 1717 AD (Sutherland et al. 2007). An earthquake of this magnitude could significantly impact regional tourism activities throughout the South Island due to physical and infrastructural damage and restricted access, as well as an unprecedented drop in visitor numbers driven by negative international media attention.

Mt Ruapehu eruptions of 1995-96

Volcanic activity in the North Island has been taking place for millions of years due to compressional tectonic forces east of the North Island as the Pacific Plate subducts beneath the Australian Plate (figure 1). In post-European times, the volcanoes and their associated geothermal hot springs began to attract visitors, and in 1887 the Tongariro volcanoes were gifted to the Crown by Maori, and designated as the country's first National Park in 1894 (Hall and Kearsely, 2001). Volcanic activity in the TVZ has impacted on tourism activities over the years. For example, the Mt Tarawera eruption of 1886 killed 120 people, and destroyed the famed Pink and White Terraces (Graham et al. 2008). In 1953, a lahar (mud/rock debris flow) spilled from the crater lake of Mt Ruapehu, destroying a railbridge and derailing a train at Tangiwai, killing 151 passengers.

More recently, ski areas have been developed on the volcanic cone of Mt Ruapehu (called Whakapapa, Turoa and Tukino). The first rope tow was installed on the mountain in 1929. By 1987 the lift capacity of the ski field had grown to 20,000 skiers per hour (Williams and Banford 1987), and latterly around 400,000 winter visitors were received on Mt Ruapehu by 2004 (Milne 2005). Houghton et al. (1997) believe Mt Ruapehu poses the greatest risk to human life of any volcano in New Zealand due to its relatively frequent episodes of activity (eruptions occurred during almost every decade of the 20th century), and the presence of a crater lake with proven potential to cause lahars.

Between September 1995 and August 1996, sustained volcanic activity during the winter season on Mt Ruapehu caused extensive ash fall over 250km away (Johnston et al. 2000). Early in this eruptive phase, on September 23rd 1995, a lahar travelled down through a ski area coming within metres of ski lift base stations and queuing areas (Johnston et al. 2000). The ski field had closed an hour before the lahar struck, which undoubtedly saved lives. The ski seasons of 1995 and 1996 were severely disrupted, with damage to infrastructure caused by ash fall and acid rains, and loss of skiing days (mainly during the 1996 season) (Table 1). Financial losses for the local tourism economy were estimated at $100 million (Johnston et al. 2000). The aviation industry was also impacted due to closure of the airspace by ash clouds, with direct losses of $2.5 million (Johnston et al. 2000).

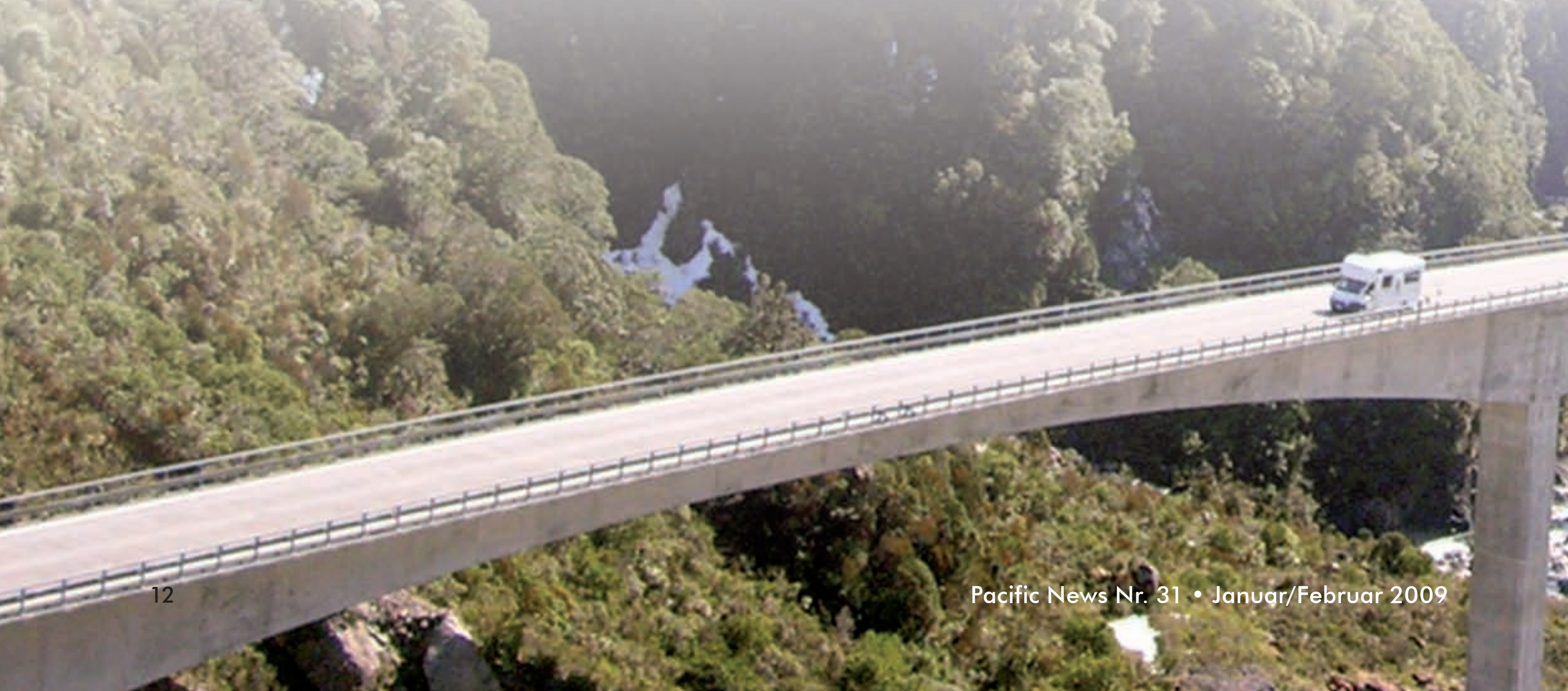


Source: Johnston et al. 2000

Map of New Zealand showing key locations. Note the position of the plate boundary is schematic, particularly the section between the North and South Island, which is in fact a complex system of faults.

Improvements in Hazard Monitoring

Partly in response to damaging hazard events in the 1990s, and in recognition of the need for improved scientific monitoring of a range of geological hazards in New Zealand, GeoNet was established in 2001. GeoNet is a government-funded initiative that provides publicly



available hazard data for earthquakes and volcanic activity, as well as landslides and tsunami. GeoNet has proven useful on a number of occasions. With the help of modern remote sensing methods and careful geochemical analysis of the Ruapehu crater lake, scientists developed a hazard warning system with the potential to greatly enhance human safety and emergency response during volcanic episodes. Alert levels ranging from 1 to 5 are issued on the GeoNet website for each active volcano in the TVZ, and whenever an alert level changes key government and public stakeholders are informed, including tourism and aviation authorities. A test for the new alerts came in early 2007, when monitoring of Mt Ruapehu showed the crater lake volume was increasing to critical levels. A lahar alert was publicly announced, and as a result the expected lahar path was kept clear. When the lahar finally came in March 2007 it caused no injury or death.

In addition, GeoNet has been instrumental in upgrading the existing lahar hazard warning system on Mt Ruapehu (Christianson 2006). The system uses seismic and acoustic data to predict the onset of volcanic activity. When earthquakes associated with volcanic activity are detected, the warning system is triggered and broadcast messages are played across the skifields warning people to move out of the valleys to high ground (as lahars will preferentially travel down into valleys) (Christianson 2006). This differs from the original more reactive warning system which was only triggered when a lahar was already on its way and offered less forewarning. In sum, one of the many positive outcomes from the introduction of GeoNet has been a significant improvement in tourist safety in ski areas on Mt Ruapehu over the past decade.

The Alpine fault

The Alpine fault is a stunningly linear geological feature which cuts through 500 km of scenic alpine terrain west of the Southern Alps, and marks the position of the plate boundary in the South Island of New Zealand (figure 1). There have been no recent large earthquakes on the Alpine fault, but paleoseismic studies indicate that the Alpine fault produces earthquakes within the 7.8-8 magnitude range approximately every 100-300 years, with the last known event occurring in 1717 AD (Sutherland et al. 2007). This event caused surface rupture of 300-350 km along the fault, with horizontal offsets of up to 9 metres, widespread landsliding in the Southern Alps, tree mortality, and aggradation (deposition) of several metres of outwash material onto the coastal strip of the West Coast. Geoscientists consider the Alpine fault to be overdue for another major earthquake.

Coincident with this zone of high seismic risk is a burgeoning tourism industry. Visitors are attracted by world-renowned scenery, where the active tectonic environment provides a backdrop to a wide range of nature-based and adventure tourism activities. The popularity of Milford Sound, Queenstown, Mt Cook and the West Coast has grown rapidly over the past decade, with projected growth in visitation of up to 24% by 2013 (Tourism Research Council 2008). A large number of visitors will spend time in National Parks, and public access is accommodated by the Department of Conservation, who are the custodians of large tracts of Crown conservation land. They provide a range of walking tracks and huts, and other amenities and facilities. Tourism activities occur in an alpine environment where climatic and physical hazard events occur relatively often, and have the potential to interrupt the flow of visitors. For example, road access to the West Coast and Milford can only be achieved via rugged, heavily forested alpine passes (figure 2), all of which are vulnerable to landslides and tree fall. Mt Cook and Milford are located at road ends, with the latter frequently cut-off due to avalanche risk or rock fall.

If a magnitude 8 earthquake were to occur today it would be felt throughout the country, with the most intense shaking occurring in and around the

Table 1: Total ski days and total revenue per season from 1993-1996

Year	1993	1994	1995	1996
Skier Days	430,000	449,000	340,000	140,000
Total revenue ($NZ)	$102 million	$107 million	$81 million	$34 million

Source: Johnston et al. 2000

The Otira Viaduct in Arthur's Pass, one of two alpine passes in and out of the West Coast of the South Island (source: D. Johnston).

Source: Johnston et al. 2000

Cyclists en route to Mt Cook Village, South Island, New Zealand.

Southern Alps. Tourism in the zone of the Alpine fault would be critically damaged by a sudden and prolonged drop in visitor numbers caused by serious damage to road access and tourism infrastructure, potential casualties and negative international media coverage. In addition, long-term damage to the aesthetic value of the forest and mountain landscape would further damage and impede the recovery of the tourism industry. Road reinstatement would be a critical factor in recovering tourism numbers, and current estimates for the West Coast State Highway (72) suggest it could take a minimum of six weeks to create basic access, with a timeframe of many years before it is returned to its current state (pers. comm. Daniel 2008).

Earthquakes differ from other natural disasters because they are 'no-escape' natural disasters that provide no lead-time for evacuation (Huan et al. 1999). Floods, volcanic eruptions and landslides can have a window of opportunity to inform local residents, businesses and visitors about impending disaster, and to initiate pre-planned evacuation or mitigation methods. To date, emergency planning by Civil Defence, in conjunction with District Councils and Lifelines providers (power, sewage, water roading, telecommunications), has gone some way towards defining roles and responsibilities in the immediate aftermath of an Alpine fault event, and prioritising lifelines work in order to speed the recovery of local communities. Tourists are difficult to coordinate and manage during a crisis, not least because most are unaware of the potential seismic risk. Informing visitors to an earthquake-prone tourism destination about the potential for a large earthquake, and what to do when one happens, is largely impractical. Instead it falls apon District Councils and tourism operators to shoulder the responsibility, by informing themselves about earthquake hazards, and ensuring they have made adequate preparations in order perform their duty of care to look after clients/visitors in the immediate aftermath of a damaging earthquake. So how prepared is the tourism industry to cope with the aftermath of a magnitude 8 Alpine fault event? Work currently being carried out by the author on the level of preparedness of tourism operators hopes to add new insights into an industry which has been neglected in the risk perception and disaster preparedness literature in New Zealand.

Conclusion

New Zealand's nature-based tourism product, coupled with its geological history and active tectonic environment, dictates that tourists will put themselves at some degree of risk by visiting popular destinations. This paper has described two natural hazards and the tourism activities that take place alongside them; skiing on the active volcanic cone of Mt Ruapehu, and nature-based tourism activities in a zone of high seismic potential in the Southern Alps. Emergency planning and hazard monitoring have advanced positively over the last decade, with GeoNet providing hazard warning systems which have reduced the risks associated with lahar and volcanic activity, as well as enhancing our network of seismographs throughout the country. Complacency, however, is the enemy of emergency planning; encouraging individuals or business operators to think through the issues involved in low frequency, high impact disaster events is a major challenge, but is one that must be faced.

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