A HISTORY OF AVALANCHE ACCIDENTS IN AOTEAROA NEW ZEALAND

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ABSTRACT: This paper is based on a study for the New Zealand Mountain Safety Council which investigated the circumstances contributing to the deaths of 128 people in avalanches between 1863 and 1999. The study identified a trend of high fatalities during European settlement followed by a lull in fatalities early last century and then an increase in recent decades similar to other recently colonized countries. Similar to other studies, most victims were in their twenties and shift from work- to recreation-based activities has occurred from a century ago to recent times. Comparison with other studies of more specific activities involved in recent decades showed that alpine climbing, people on training courses, in-area-skiers and patrollers were over-represented, while out-of-area skiers/boarders and snowmobilers were under-represented. The geographic distribution of fatalities is concentrated in the South Island reflecting the preponderance of terrain for climbing and skiing.

Keywords: fatalities, New Zealand, avalanche victim activities

1. INTRODUCTION

This paper is based on an investigation of snow avalanche fatalities undertaken for the New Zealand Mountain Safety Council (Irwin et al. 2002). It covers the period 1860 to 1999 and aims to describe and compare with other similar studies avalanche fatality rates and trends, seasonal occurrence of fatalities, the age, gender and activities of people involved and the geographic distribution of fatal avalanche accidents.

2. CONTEXT: PHYSICAL BACKGROUND AND MOUNTAIN USE

New Zealand has a relatively high proportion of avalanche terrain with seasonal snow on relatively steep slopes covering approximately 35% of the South Island and about 5% of the North Island. The major mountain areas in the North Island are volcanic peaks of Ruapehu and Taranaki while in the South Island the topography varies between the steep and dissected Southern Alps, the deeply glaciated valleys of Fiordland and the block mountains of Otago. Mountain climates reflect the maritime location in the zone of mid-latitude westerlies such that winter temperatures are warmer than for similar latitudes and elevations in the northern hemisphere. The winter snowline is near the elevation of timberline which varies from about 1000m in Fiordland to nearly 2000m in the north. Because of warm temperatures, precipitation may fall as rain to ridgelines of 2000 to 3000m at any time of year yet faceting within the snowpack is possible especially in areas away from the coast. The climate is also characterised by rapid changes associated with cold front onset and passage and because of the exposure high windiness.

Mountain activities are focussed around extensive pastoralism and recreation with a large proportion of the mountain areas in national parks and similar reserves. Information on numbers of people involved in recreation on seasonal snow is difficult to obtain though it is clear that there have been large increases in recent decades. The largest numbers are on the four North Island and twenty South Island skifields. Smaller numbers are involved in heli-skiing, climbing and tramping (hiking) in snow covered terrain. The only significant public highway affected by avalanches is the Milford Road in Fiordland.

3. INFORMATION SOURCES

A variety of sources were used for collecting data about avalanche fatalities. Information from the early period is restricted to books and newspaper articles and it is thought that many events involving exploration and mining may

have been missed. As mountain clubs developed in the early part of the twentieth century, journals and bulletins became a source of information. For events from 1970 onwards we have used Coroners' reports. Since 1981, the New Zealand Mountain Safety Council's Snow and Avalanche Committee has completed an annual survey of avalanche incidents and while this is not very complete in regard to non-fatal involvements, the record of fatalities for this period is probably quite accurate. Information from this source through 2003 is used to supplement that discussed by Irwin et al. (2002).

Because of the difficulty in distinguishing between snow and ice avalanches in some reports, we have included both types of avalanches in this survey.

Several studies of avalanche fatalities have been undertaken in other mountainous countries. From these it is possible to compare a number of characteristics including absolute numbers of fatalities, trends over time and activities and characteristics of the victims of avalanche accidents.

4. AVALANCHE FATALITIES

In the years between 1860 and 1999, records detail the deaths of 128 people resulting from avalanches. Fig. 1 shows the historical distribution of avalanche deaths in Aotearoa New Zealand.

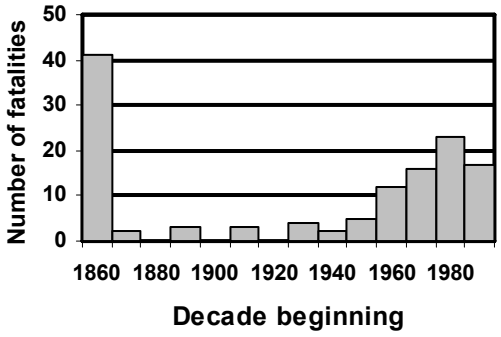

Figure 1: Distribution of avalanche deaths by decade 1860-1999.

The statistics suggest that the average number of deaths resulting from avalanches has steadily increased through the years (except for an event in 1863 involving the deaths of 41 people). The data in Fig. 1 indicate an increase in the average annual fatality rate from about 0.2 in the early years of last century to approximately 2.0 at the end of the century.

The increase in the average number of fatalities over the last five or six decades is likely due to an increase in population coupled with an increase in the popularity of alpine recreation activities. Over the last decade, the average number of yearly fatalities has declined and may be a result of increased avalanche awareness and better dissemination of avalanche information.

Total fatalities in alpine countries are reported by IKAR (International Commission for Alpine Rescue) as shown in Table 1 that also shows deaths per capita. Total population is only a very crude measure of numbers of people in avalanche terrain but unfortunately there are very few other data available to give a better indication of participation rates.

Table 1: Avalanche fatalities by country

Country	Fatalities/ Year[1]	Fatalities/ million/year
France	30.3	0.52
Austria	26.1	3.26
Switzerland	22.8	3.17
U.S.A.	19.4	0.07
Italy	19.0	0.33
Canada	10.1	0.35
Norway	4.9	1.12
Spain	4.4	0.11
Slovakia	3.2	0.59
Poland	2.3	0.06
Germany	2.2	0.03
N.Z.	2.0	0.50
Slovenia	1.4	0.69
U.K.	1.0	0.02
Bulgaria	0.8	0.09
Croatia	0.8	0.15
Czech Rep	0.2	0.02
Liechtenstein	0.0	0.00

(1 -Colorado Geological Survey (2004))

This table indicates that New Zealand lies in an intermediate zone along with Slovenia, Slovakia, France, Canada and Italy between very high per capita fatalities of over 1.0 fatality/million/year and much lower rates of less than 0.2 fatalities/million/year.

Trends over time in different countries seem to depend on the length of time that mountainous areas have been inhabited. For those countries with a long history of occupancy in the mountains, for example France, Switzerland, Norway and Austria, the record shows that in the long term, numbers of fatalities have decreased and in the last 40 to 50 years have remained relatively stable. An example of this pattern is shown for Austria in Fig. 2. Meister(2001) has shown that the fluctuations from year to year for the European alpine countries result from different weather and snowpack conditions and are relatively similar from country to country. The most recent example of this effect was the large numbers of fatalities in France, Switzerland and Austria during the severe winter of 1998/99.

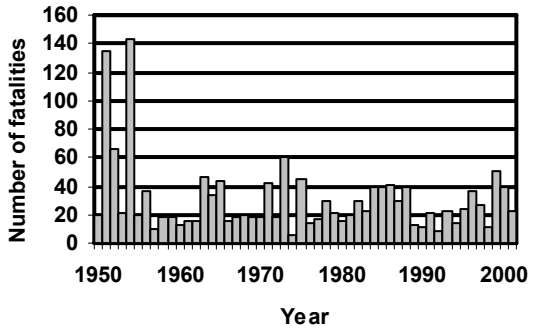

Figure 2. Avalanche fatalities in Austria (Höller, 1997; Höller pers.comm.)

In contrast to this pattern, countries with only relatively recently settled mountainous areas are characterised by recent increases in fatality numbers though they may have had high fatalities during periods of colonisation as a result of mining and development of transport links. The time series for the United States shown in Fig. 3 almost directly parallels the New Zealand data (Fig. 1) although the mining fatalities that make up the early period, (mainly in Colorado), occurred at a slightly later date than the central Otago disaster. Increases in fatalities in recent decades clearly reflect increased numbers of people involved in recreation and possibly greater use of uncontrolled areas, though it is difficult to obtain hard data to back this up. Jamieson and Geldsetzer (1996) indicated that in Canada from 1976 to 1994, the numbers of recreationists were increasing at a faster rate than the fatalities.

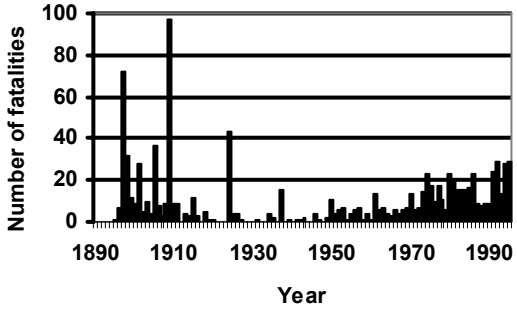

Figure 3: Avalanche fatalities in the United States (Doesken and Judson 1996)

5. SEASONAL OCCURRENCES OF AVALANCHE FATALITIES

Avalanche fatalities occur throughout the year. However, as indicated in Fig. 4, 71% of fatalities in Aotearoa New Zealand have occurred in the period June to September, and a further 19% have occurred in November, December and January. There are few fatalities in the February to June period.

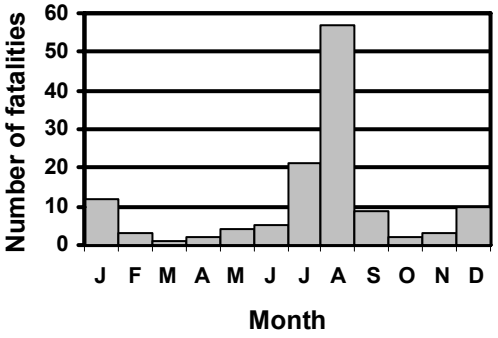

Figure 4: Seasonal Occurrence of Avalanche Fatalities 1869-1999

However the seasonal distribution of a more recent data set (1981-2003) indicates a stronger summer spike in fatalities (Fig. 5). Not surprisingly, most overseas studies show that fatalities are most common in the winter months with high numbers in January to March in Canada (Jamieson and Geldsetzer 1997) and

the United States (Atkins and Williams 2000) and in January and February in France (Jarry and Sivardière 2000). Fig. 5 shows that the peak occurrence is relatively short in New Zealand which may reflect the longer duration of snow cover in continental climates. However, none of the overseas studies showed as strong a secondary summer peak as seems to exist in New Zealand, probably as a result of a high level of climbing activity in December and January.

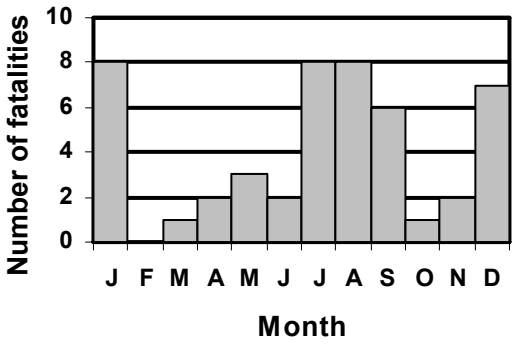

Figure 5: Seasonal occurrence of avalanche fatalities

6. AGE AND GENDER

Although the details of many accidents are incomplete, it is likely that more than 90% of avalanche fatalities in this country have been male. If this statistic is combined with the data presented in Fig. 6 it can be concluded that most avalanche victims are males in their twenties.

Figure 6. Percentage of avalanche fatalities by age

Very little information on age distributions of avalanche victims in other countries seems to be available. That which is available (Table 2) confirms the concentration in the 20 –29 year band while there seem to be fewer young fatalities in New Zealand while in the older age groups, New Zealand is intermediate between the United States and Canada. Atkins and Williams (2000) report an increase in the age of avalanche victims in recent decades but the New Zealand data are too few to allow this to be identified. These trends in age distributions are probably related to the activities of avalanche victims, particularly the recent increase in snowmobile use in avalanche terrain.

Table 2: Percentage of fatalities in different age groups

Age range	Canada[1] (1984- 96)	U.S.A.[2] (1950-99)	New Zealand (1860-1999)
>60	3	5	3
50-59	14		7
40-49	17	12	13
30-39	24	25	23
20-29	38	51	51
<20	6	17	3

(1 - Jamieson and Geldsetzer (1996),
2 - Atkins and Williams (2000))

7. ACTIVITIES

Before the 1940s most avalanche fatalities occurred as a result of people working in avalanche terrain (e.g. mustering or mining). With the discovery of gold, many people were drawn to the mountain regions of the South Island where the earliest historical account of avalanche involvement is in 1863. However, miners were secretive of their explorations and it is probable that many avalanche accidents occurred that never became public knowledge.

Since that time the vast majority of accidents have involved people undertaking a variety of recreation pursuits in alpine terrain. As shown in Table 3, most of those killed are alpine climbers. However, it is also worth noting the significant number of people who die while undertaking some form of avalanche or mountain training. The more recent data set emphasises these trends.

Table 3: Percentage activities involved in avalanche fatalities during two different periods

Activity	1860-1999 (n=128)	1981-2003 (n=48)
Alpine climbing	35	60
Mining	32	0
Training	9	15
Tramping	5	4
Rescue	4	2
Ski area work	3	4
Road work	3	2
Skiing in area	3	2
Ski touring	2	4
Mustering	2	0
Heli-skiing	1	2
Skiing out of area	0	2
Snow sports ops	0	2

8. FATALITIES RELATED TO WORK COMPARED TO RECREATION

Those fatalities resulting from avalanche while undertaking work or recreation activity are presented in Fig. 7.

The number of work-related fatalities has remained relatively static despite significant increases in the number of people working in the mountain environment. This is probably due to a number of factors including improvements in avalanche safety guidelines and industry practices, training, and management systems.

However, in the period since 1960, recreation-related fatalities have increased. The higher numbers of recreation-related fatalities (in comparison to work-related fatalities) might be attributed to a number of factors including:

- The increased number of people involved in winter mountain recreation;
- The time constraints of short visits;
- A lower level of skills, knowledge and experience;
- A lack of familiarity with the environment;
- Less access to relevant information;
- An absence of systematic decision making processes regarding snow stability and avalanche hazard;
- A lower perception of avalanche hazard;
- More rapid access to mountainous areas after storms

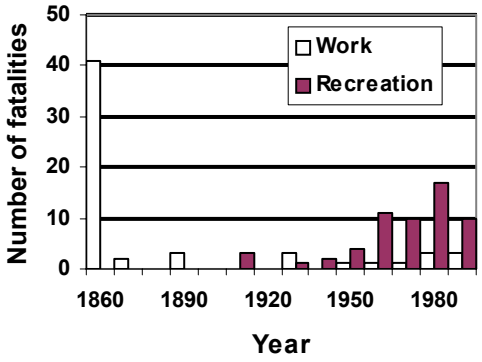

Figure 7: Fatalities (recreation and work activity) ***Note:*** *Rescue has been considered a work activity. The 12 Fatalities occurring on training courses have not been considered work or recreation and therefore not included.*

However, the decisions required to ensure the safety of people in avalanche terrain are essentially the same regardless of whether the activity involves recreation or work.

Over longer time periods, there has been a definite shift from non-recreation (or work-related) fatalities to those associated with recreation in both relatively recently settled mountain areas and those where alpine settlements are well established. This is shown in Table 4 and in Fig. 8. The latter demonstrates that in recent years, it is only in very severe winters such as 1998/99 that non-recreation fatalities become a problem. The specific activities involved in recent decades are more difficult to compare because of rapid changes in some countries (for example the rapid increase in snowmobile accidents in North America in recent decades), a lack of published material and particularly because different classifications are used in different countries.

Table 5 compares data obtained for two European countries and the United States and Canada. The categories of activities used in this and other studies have been combined in some cases to facilitate comparisons, even though this may lead to a loss of information. For example, no distinction between climbing and ice climbing has been made while for the French data, off piste activities have been grouped with back-country uses in the out of area ski/boarder category though it is realised that the latter includes activities such as snowshoe walking.

Table 4: Percentage of recreation and non-recreation fatalities for selected periods and countries.

Country/years	%Non-recreation[1]	% Recreation	Source
Norway			**Kristensen (1998)**
1947-76	**62**	**38**	
1977-97	**44**	**56**	
Japan			**Ikeda et al.(2000)**
1924-60	**70**	**30**	
1961-92	**1**	**99**	
Switzerland			
1875-1975	**52**	**48**	**Frutiger (1977)**
1981-2001	**13**	**87**	**Schweizer and Föhn (1996)**
New Zealand			
1860-1959	**91**	**9**	**This study**
1960-1999	**30**	**70**	

1 – Training accidents included in non-recreation

The training category has been retained even though Norway is the only other country that the authors are aware of that has reported data of this type. In the case of Norway almost all training fatalities arose from one disastrous accident which led to the death of sixteen soldiers (Lied 1988). This is the only significant point of similarity between New Zealand and Norway, which as previously noted, has a very high proportion of non-recreation related fatalities. When comparing the New Zealand data with other countries shown in the table, the other main points are the relatively high proportion of climbing and in ski area fatalities, and the low proportion of out of area and snowmobiling deaths.

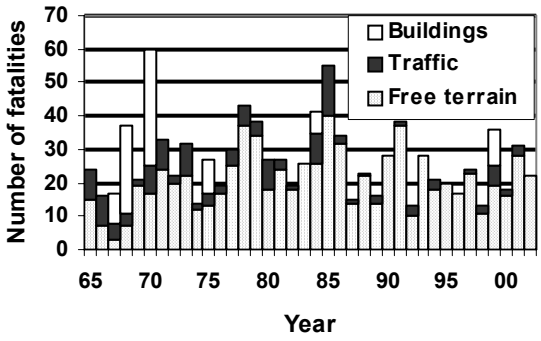

Fig. 8: Swiss avalanche fatalities by activity 1966/65 – 2000/01 (Schweizer and Föhn 1996 and Schweizer pers. comm.).

9. GEOGRAPHIC DISTRIBUTION

The spatial distribution of the 128 avalanche fatalities through the study period is presented in Figure 9. Around 95% of the fatalities occurred in the South Island, while the remaining 5% occurred in the North Island. In the South Island, most fatalities occurred in the Mt Cook region (around 27%) and Central Otago Ranges (around 36%).

These figures likely reflect the focus of mining activity, backcountry recreation activity, and overall distribution of the ski areas in the South Island of New Zealand.

Table 5: Activities of avalanche victims in different countries as percentage of total fatalities.

Country	USA[1]	Canada[2]	France[3]	Norway[4]	NZ[5]
Years	1985-01	1984-96	1989-99	1947-97	1970-99
Climbing	**16**	**21**	**18**	**2**	**55**
Out of area ski/boarder	**40**	**50**	**71**	**37**	**5**
In area skiers and patrollers	**3**	**0**	**4**	**0**	**11**
Snowmobilers	**25**	**20**	**0**	**2**	**0**
Other recreation	**10**	**6**	**0**	**4**	**5**
Traffic	**1**	**0**	**0**	**4**	**0**
Residents	**2**	**3**	**4**	**28**	**0**
Other work	**2**	**0**	**3**	**16**	**2**
Training	**0**	**0**	**0**	**7**	**22**
Total numbers of fatalities	**327**	**114**	**316**	**270**	**55**

1. Colorado Geol. Survey (2004); 2. Jamieson and Geldsetzer (1996); 3. Jarry and Sivardière (2000); 4. Kristensen (1998); 5. This study

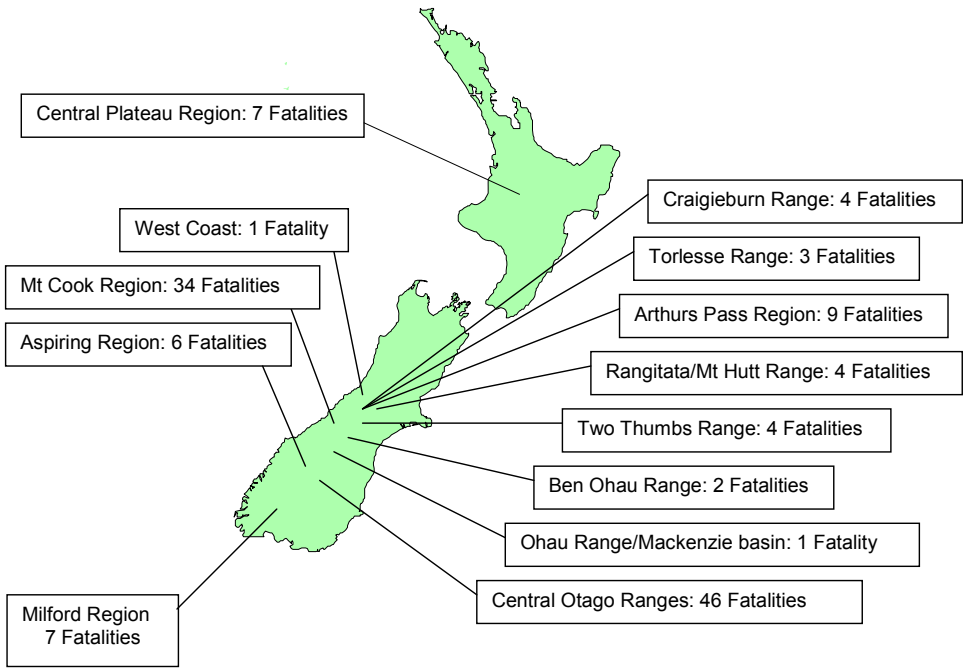

Figure 9: Geographic distribution of Avalanche Fatalities 1860-1999

10. SUMMARY

This paper has discussed the nature and circumstances of avalanche fatalities in Aotearoa New Zealand and related those statistics to data from other parts of the world. The pattern of change over time is similar to other countries where mountain areas have recently been inhabited. There have been increasing numbers of avalanche fatalities in recent decades such that Aotearoa New Zealand lies in the moderate category of fatalities capita of population and the majority of victims appear to be males in their twenties. Like many other countries there has been a shift from work- to recreation-based activities involved in fatalities but when specific activities are compared, climbers, people on training courses and in area skiers and patrollers are over-represented while out of area ski/boarders and snowmobilers are under-represented. The geographic distribution reflects the concentration of climbing and skiing activities in the South island.

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