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Avalanche accidents and fatalities in Austria since 1946/47 with special regard to tourist avalanches in the period 1981/82 to 2015/16

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ABSTRACT

Avalanches are one of the principal natural hazards in alpine regions, frequently resulting in property damage and fatalities. This paper indicates and analyses avalanche accidents and particularly avalanche fatalities within the last 70 years in Austria.

While from 1946/47 to 1980/81 accidents due to catastrophic avalanches prevailed, the following period (1981/82 to 2015/16) was characterised by a predominance of backcountry avalanche accidents and a decrease of catastrophic avalanches. That declining trend is the result of comprehensive mitigation measures in Austria, which were implemented as a consequence of the major avalanche events in the 1950s. In particular, the number of disastrous avalanche events (events with five or more fatalities) decreased significantly.

Although a few disastrous events also occurred in the backcountry, the vast majority of avalanche accidents caused only one or two fatalities. However, the number of avalanche fatalities did not change significantly, while the number of skiers and mountaineers has increased considerably in the last 20 to 30 years. Compared to off-piste fatalities, avalanche deaths due to backcountry skiing were clearly predominant in the 1980s. This relation decreased over the years, or in other words, the rate of off-piste fatalities (in proportion to backcountry fatalities) increased, relatively speaking; however, a clear trend could not be found.

1. Introduction

At all times settlements and infrastructures in mountainous regions have been endangered by avalanches; also Austria has not been spared. Winter periods with an outstanding number of avalanche fatalities were reported from 1688/89 (Haid, 2007; Schott, 2005) and 1887/88 (Franz, 1888; Haid, 2007) as well as from 1916/17 (front-line between Italy and Austria). More recently, the seasons 1950/51 and 1953/54 indicate a large number of fatalities due to several extraordinary catastrophic avalanche events (Höller, 2009, 2015).

In the past, it was almost exclusively settled areas and villages that were affected by avalanches.

Specific mitigation measures (e.g. stonewalls) which were constructed by local inhabitants were already used in the 17th century to protect buildings and farm houses from avalanches (BMLF, 1989). The earliest comprehensive project (designed and constructed by the Austrian Service for Torrent and Avalanche Control) was implemented in 1897/98 close to the Raxalpe (Federal State of Lower Austria) (BMLF, 1989). In the 20th century (in particular following major events in 1954) a comprehensive construction program was initiated in order to protect settlements, roads and other infrastructure from destructive avalanches.

However, the development of alpine skiing at the end of the 19th century and the strong increase of backcountry skiing in the second half of the 20th century implicated that a rising number of humans encountered avalanche terrain and accidents relocated more and more into uncontrolled areas (Techel et al., 2016). The remarkable rise in winter overnight stays in Swiss mountain huts since the 1970s can be used as evidence for an increase in backcountry activity (Zweifel et al., 2006). Data for Austria are not available; there are only a few estimates. The Austrian Alpine Club indicated that during the end of the 1990s there were about 250,000 backcountry skiers in Austria (<http://salzburg.orf.at>, 2008); the corresponding number for 2012 was estimated at about 700,000 (<http://noe.orf.at>, 2012). In the 'Standard' from 15 January 2012, Thomas Wiesinger, a renowned avalanche expert, estimated that there were up to 650,000 backcountry skiers in Austria (<http://derstandard.at>) and in www.springermedizin.at from 18. January 2016 Rudi Mair, head of the Avalanche Warning Service in Tyrol, determined a number of about 700,000 backcountry skiers.

Techel et al. (2016) mentioned that avalanche statistics often rely on a relatively small number of events. Moreover, records on avalanches depend on the severity of incidents; accidents with fatalities are often well-documented, while data on accidents without consequences are not always collected. According to Meister (1987), who

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analysed fatal avalanche accidents in Switzerland from 1936/37 to 1985/86, a homogenous database is available only for accidents that claimed human lives; for all other incidents (with injured persons or those merely caught in the incident) the number of unknown cases is relatively high. [Techel and Zweifel \(2013\)](#) assumed that approximately 20% of avalanche involvements in Switzerland are not recorded. [Jamieson and Jones \(2015\)](#) estimated for Canada that in the last 20 years only about 10% of non-fatal involvements were reported; this rate has been increasing since the possibility of online reporting, which started in Canada in 2009. [Edgerly \(2010\)](#) found that in the United States almost 40% of the companion rescue incidents were unreported.

The quality of records in Austria increased in the middle of the 20th century; however, reliable data on accidents in the backcountry have been available since the beginning of the 1980s when the KURASI (Österreichisches Kuratorium für Alpine Sicherheit – Austrian Board for Alpine Safety) commenced a continuous analysis of backcountry accidents.

For this reason, the analysis of backcountry accidents is based only on data from 1981/82 onwards, while the general investigations in this paper (with regard to the overall statistics and catastrophic avalanches) include the entire period from 1946 until 2016.

The purpose of this research was

- * highlight the history of fatal avalanche accidents in Austria within the last 70 years.
- * to consider the development of ‘tourist avalanches’ over the course of time.
- * to analyse skiing accidents with regard to the number of fatalities per accident (1981/82 to 2015/16).
- * to investigate the relation between avalanche fatalities due to backcountry skiing and fatalities through off-piste skiing (1981/82 to 2015/16).

2. Data and methods

Data of avalanche accidents are from the KURASI, the BFW (Bundesforschungszentrum für Wald – Austrian Research Centre for Forests), the ICAR (International Commission for Alpine Rescue) and from own inquiries. Additional sources were publications by [Fliri \(1998\)](#), [Haid \(2007\)](#) and [Schott \(2005\)](#). The KURASI data are based on reports of the Alpine Police and mountain rescue and include descriptions of all known avalanche accidents going back to the 1980s. However, avalanche accidents without consequences were not always collected in a continuous way. As shown in the Introduction the number of unknown cases is relatively high for incidents with only injured or caught people. Nevertheless the KURASI data also include details concerning the site of the accident (backcountry or off-piste); for accidents in earlier years (before the 1990s) this information was excerpted from the existing descriptions in the annual reports of the KURASI and checked against the ICAR data.

BFW data, in particular, include a comprehensive set on catastrophic avalanches (going back to 1968). Here, too, the above-mentioned remarks about missing data have to be considered.

Personal inquiries of the author were implemented to validate the above-mentioned datasets and to complete it in terms of the missing period (1946 to 1968); these inquiries are based on [Fliri \(1998\)](#) as well as on old newspaper reports. For a countrywide overview the ‘Die Presse’ and the ‘Arbeiterzeitung’ (both revived immediately after World War II) were used, supplemented by two regional newspapers (‘Salzburger Nachrichten’ and ‘Tiroler Tageszeitung’). However, it can be assumed that these newspapers probably do not report on all avalanche accidents; thus the respective newspaper articles were checked against systematic records by [Fliri \(1998\)](#). Additionally, we collected the records from the SLF (annual winter reports - Winterberichte); from 1946/47 these reports also included avalanche accidents outside of Switzerland (at least those with fatalities). Along with these documents

it was possible to establish fatal avalanche accidents from 1946 to 1968.

To allow a separate analysis, data were divided into catastrophic avalanches and backcountry avalanches. The term catastrophic avalanche is used when people in settled or developed areas are caught or buried by an avalanche that released high up in the mountains ([de Quervain, 1972](#)). They are triggered naturally and affect local inhabitants, road users or people accommodated in hotels and apartments. Backcountry avalanches – often called tourist avalanches ([de Quervain, 1972](#)) – appear in remote areas or high alpine regions and are primarily triggered by humans themselves; this category contains not only accidents involving backcountry and off-piste skiers, but also hikers, mountaineers and climbers. However, since the principal interest of this paper is to analyse the development of skiing accidents, the second part of the paper only refers to avalanche accidents with backcountry skiers and off-piste skiers. Backcountry skiers use ski slopes in alpine terrain (not controlled, not marked), mostly away from ski areas; off-piste skiers use cable cars or skilifts and ski on slopes that are neither maintained nor marked, but are close to the ski area. It applies to both categories that each skier has to assess the local avalanche danger themselves and is responsible for his/her own safety. According to [de Quervain \(1972\)](#), the separate classification of catastrophic and tourist avalanches is reasonable as they occur at different times and in different locations.

In order to indicate an approximate trend with regard to avalanche fatalities, the entire period (1946/47 to 2015/16) was divided into two halves (1946/47 to 1980/81 and 1981/82 to 2015/16). Special emphasis was given to the characterisation of the most disastrous events which were defined as accidents with five or more fatalities.

Skier accidents (avalanche accidents involving backcountry skiers and off-piste skiers) additionally, have been analysed regarding to the number of fatalities per accident. In terms of a frequency distribution the accidents were allocated with respect to the specific numbers of deaths (separated according to accidents with one, two, three, four and five fatalities). These results may be an indication that risk reduction measures, such as maintaining a certain distances between group members, have had an influence on the fatalities per accident.

Additional attention was focused on the relation between avalanche fatalities due to backcountry skiing and fatalities through off-piste skiing. These results should verify the assumption that avalanche accidents increase in off-piste terrain, a thesis that is frequently mentioned by the media ([Harvey and Zweifel, 2008](#)).

In order to interpret the several time series the Mann-Kendall test was used; it was assumed that a p -value of < 0.05 indicates a significant trend.

3. Results

During the last 70 years, approximately 2000 persons have been killed by avalanches in Austria, which corresponds to an average of about 30 fatalities per year. There were approximately 1500 deaths in the backcountry (tourist avalanches) and about 500 fatalities due to catastrophic avalanches ([Fig. 1](#)).

Between 1946/47 and 1980/81 (the first half of the entire period) the number of fatalities amounted to > 1100 with approximately 650 deaths due to tourist avalanches (this number contains all fatalities in the backcountry as backcountry skiers, off-piste skiers, hikers, mountaineers, climbers and crosscountry skiers) and about 460 due to catastrophic avalanches.

In the second half (1981/82 to 2015/16) the total number of fatalities was 909 [833 deaths due to tourist avalanches (all fatalities in the backcountry) and 76 due to catastrophic avalanches].

The ratio between the number of victims in the backcountry and the number of victims due to catastrophic avalanches has considerably changed from the first to the second period ([Table 1](#)).

The percentage of fatalities due to catastrophic avalanches (ratio of

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