PATTERNS OF RECREATIONAL BACKCOUNTRY USAGE - ANALYZING DATA FROM SOCIAL MEDIA MOUNTAINEERING NETWORKS AND AVALANCHE STATISTICS

F. Techel[1*], B. Zweifel[1], K. Winkler[1], R. Baur[2]

[1] WSL Institute for Snow and Avalanche Research SLF, 7260 Davos, Switzerland
[2] Bergportal GmbH

ABSTRACT: Most avalanche accidents involving people occur during recreational activities. So far, risk analysis studies mostly rely on accident statistics without considering exposure (or the elements at risk), i.e. how many, when and where people are recreating. As backcountry usage data is scarce, we explored condition reports on social media mountaineering networks. We compared more than 15'000 reports posted on bergportal.ch and camptocamp.org with accident data. We noted similar patterns in avalanche accident data and user data with respect to demographics of recreationists. Considerably more accidents and activities were recorded on weekend-days rather than weekdays and during fine rather than poor weather conditions. On days with fine weather and lower avalanche hazard more challenging backcountry tours were undertaken. While backcountry touring accidents were equally frequent at danger levels 2 and 3, usage frequencies were twice as high on days with danger level 2. The odds of being involved in an avalanche accident increased by a factor of 5 from danger level 1 to 2, and a factor of 2 between higher danger levels.

KEYWORDS: avalanche accident, avalanche risk, backcountry usage, avalanche danger, social media

1. INTRODUCTION

Winter sport recreation in backcountry terrain has become increasingly popular during recent decades. However, when venturing into the backcountry the avalanche hazard must be considered. While avalanche accidents are relatively rare, they may have severe consequences leading to loss of equipment, injury, or even death.

During recent decades, considerable efforts have been put into providing recreationists with tools to check the risk of winter sport activities in backcountry terrain. At the forefront of these efforts, Munter (1992, 1997) developed the reduction method, a simple tool for backcountry recreationists to check their risk. Following the criteria given in the variable decision frameworks would have prevented a significant number of accidents (McCammon and Haegeli, 2004).

These risk reduction frameworks are generally solely based on accident statistics. However, the lack of empirical backcountry usage data often limits studies investigating the risk in recreational activities in avalanche terrain or evaluating these frameworks. With few exceptions (e.g. Grimsdottir and McClung, 2006, Zweifel and Wäger, 2008, Procter et al., 2013), there is no empirical data on recreational backcountry usage available. To fill this gap, we explored to what extent condition reports posted on social-media mountaineering networks may provide reliable information on backcountry usage. For this, we combined accident data from the Swiss avalanche accident database with backcountry usage data originating from two social-media mountaineering websites (www.bergportal.ch and www.camptocamp.org), where recreationists share information on mountaineering conditions.

The aims of this study are to (1) describe backcountry ski touring activity patterns in respect to the encountered conditions and (2) detect relevant factors and their combinations for high risk of avalanche accidents.

2. BACKGROUND

During the last years, about 95% of avalanche accidents involving people in Switzerland occurred during winter sports activities in the backcountry (Techel and Zweifel, 2013). In 90% of the cases, the recreationists triggered an avalanche themselves (e.g. Schweizer and Lütschg, 2001; Techel and Zweifel, 2013). The majority - about two thirds - of the avalanche fatalities happened during backcountry tours on ski, snowboard or snowshoe,

* Corresponding author address:
F. Techel, techel@slf.ch, +41 81 417 0349, WSL Institute for Snow and Avalanche Research SLF, Davos, Switzerland

the remaining mostly while out-of-bounds skiing near ski areas.

The likelihood of triggering an avalanche and the risk of damage to people to occur by an avalanche increases with increasing avalanche danger and decreasing snow stability (e.g. Munter, 1997; Harvey, 2002; Grimsdottir and McClung, 2006; Pfeifer, 2009; Jamieson et al., 2009). Harvey (2002) showed that the proportion of accidents at different danger levels was influenced by the activity of the accident party –with almost equal accident numbers at danger level 2 and 3 during backcountry touring, contrasting to out-of-bounds skiing where most accidents occurred at danger level 3. These differences can in part be explained by different usage patterns: for example the number of users undertaking ski tours in the region of Davos (Switzerland) was only half as high on days with danger level 3 compared to danger level 2, while out-of-bounds skiing frequencies were similar at the two danger levels (Zweifel and Wäger, 2008).

Facts concerning the characteristics of accidental avalanches (size, location, terrain, snowpack, human factors) are well described (e.g. Schweizer and Lütschg, 2001; Harvey, 2002; Zweifel et al., 2012; Techel and Zweifel, 2013). However, there is still a lack of empirical, objective data concerning the human behavior in avalanche terrain (Hendrikx et al., 2013).

3. DATA

We explored data always for the period 1 December to 30 April and for the region of the Swiss Alps.

Activity: Backcountry activity was taken from the condition reports on the two social media mountaineering websites www.bergportal.ch (hereafter bergportal) and www.camptocamp.org (hereafter camptocamp). On these two portals, registered users describe their backcountry touring and mountaineering activities. Any internet user can view these reports. For our study, we considered only backcountry touring activities, either by ski, snowboard or snowshoe. Using wikipedia-style guidebooks, route difficulty is graded in 7 levels according to the SAC backcountry ski-touring scale (SAC, 2012) in bergportal and using the global ski difficulty (camptocamp, 2014a) in camptocamp. We used data for the 5-year period from winter 2009/10 to winter 2013/14 totaling more than 15’000 reports (Figure 1, Table 1).

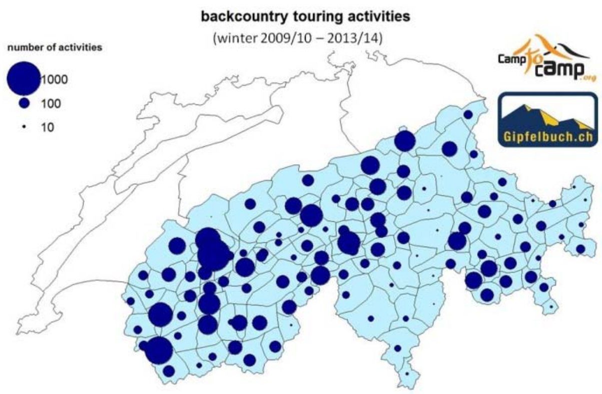

Figure 1: Spatial distribution of activities during the five winters 2009/10 - 2013/14. The size of the darkblue circles represents the number of reported activities for each of the Alpine avalanche forecast areas used to regionalize the Swiss avalanche bulletin.

Accidents: We extracted avalanche accident data from the Swiss avalanche accident database. As the total number of accidents was much smaller than the reported backcountry touring activities in a similar 5-year period, we selected a 10-year period as a more representative and robust data set. To allow comparison of the datasets activity and accidents, we restricted the dataset to accidents during backcountry touring, and excluded off-piste accidents in this analysis (Table 1).

Weather: We used the modal value per region of the manual morning weather observation from the SLF observer network. Weather observations were classified into the three categories:

1 - fine: less than 50% cloudiness,

2 - fair: if neither category 1 nor 3

3 - poor: precipitation, storm, poor visibility (fog)

Avalanche danger: We extracted the avalanche danger level from the evening forecast of the Swiss avalanche bulletin - issued at 5 pm - and valid for the next day (SLF, 2013).

Table 1: Data overview of activities and accidents. The values in brackets show the proportion of the data for which the parameter was available.

Parameter	Bergportal N = 10479 reports by 1476 users	Camptocamp N = 5107 reports by 736 users	Accidents backcountry touring N = 748 with 1321 people caught	
	5 winters 2009/10 to 2013/14	5 winters 2009/10 to 2013/14	10 winters 2003/04 to 2012/13	
Date	(100%)	(100%)	**Date**	(100%)
Summit	elevation [m] (100%) coordinates (100%)	elevation [m] (100%) coordinates (100%)	**Start zone**	elevation (89%) coordinates (100%)
Tour	route difficulty (68%) reached summit (100%)	route difficulty (93%)	**Start zone**	max. slope angle (46%)
Group	group size (98%)		**Group**	group size (82%)

4. METHODS

For each activity report and avalanche accident, we used the modal value of the weather conditions (climate region) and the avalanche hazard forecast (issued for the forecast area).

We compared the datasets activity and accidents between each other, but also to the base rate of weekdays, weather conditions and forecasted avalanche danger. The base rate was used to standardize the observed frequencies of activities and accidents. Frequency data are shown in contingency tables. We applied the chi-square-test to the contingency tables to compare the distributions between the data sets (Crawley, 2007).

Many of the parameters are of ordinal nature (for instance route difficulty, avalanche danger). For the purpose of our analysis, we assumed equal intervals between levels. We used the non-parametric Mann-Whitney test to compare two populations and the Spearman rank order correlation to investigate monotonic trends (Crawley, 2007).

Samples were considered significantly different when the level of significance was ≤ 0.05.

5. RESULTS AND DISCUSSION

5.1 *Seasonal and weekday distribution*

The seasonal distribution for activities and accidents was similar with the highest numbers during the months January, February and March. Activities and accidents were much more frequent on weekend-days than weekdays (Table 2) with about three times the number on weekend-days compared to weekdays (activities: factor 3.3; accidents: factor 2.6).

5.2 *Weather conditions*

Activities and accidents had a similar distribution and were proportionally more frequent during fine weather than on days with poor weather conditions (Table 2, $p<0.01$). The number of activities was 2.5 times and the number of accidents 1.8 times higher during fine weather, compared to poor weather. Although the difference between activities and accidents was not significant, these numbers hint at a higher accident risk in poor weather conditions.

5.3 *Avalanche danger*

Most activities as well as most accidents occurred at danger level 2, which was also the most frequently forecasted danger level (Table 2). However, the frequency of activities and accidents differed significantly at the different danger levels ($p<0.01$). The number of activities was twice as high on days with danger level 2 compared to danger level 3 (corresponds also to Zweifel and Wäger, 2008), while accident numbers were almost evenly distributed at these two danger levels. Danger level 4 was issued very seldom and relatively few activities and recreational accidents were recorded on these days. Comparing the frequencies of activities and accidents to the distribution of the forecasted danger levels, we note that relatively more people ventured into the backcountry on days with lower predicted avalanche danger levels (levels 1 and 2), compared to accidents, which were more frequent on days with danger level ≥3 (Figure 2).

Table 2: Frequency distributions for the day of week, weather and avalanche danger level

	Day of week		Weather			Avalanche danger level			
	Weekday	**Weekend**	**Fine**	**Fair**	**Poor**	**1**	**2**	**3**	**4**
base rate	71%	29%	57%	21%	22%	16%	48%	33%	2%
activities	43%	57%	80%	8%	12%	17%	55%	28%	0.2%
accidents	48%	52%	70%	15%	15%	2.7%	49%	47%	0.6%

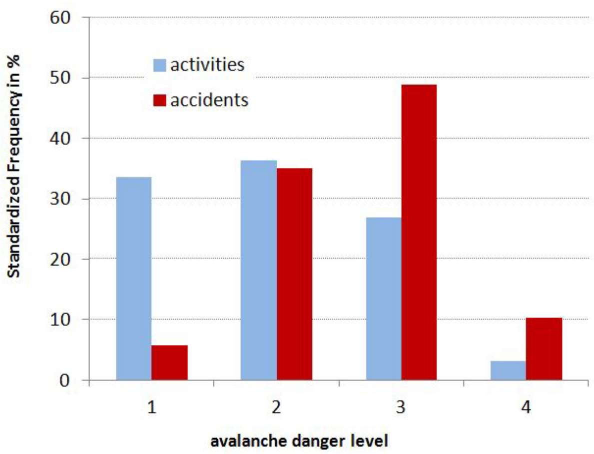

Figure 2: Frequency of activities and accidents, standardized by the base rate of the forecasted danger level (see Table 2).

5.4 Terrain and conditions

Generally, summits with higher elevation were the goal on days with fine weather and a lower avalanche danger. The proportion of routes with grades higher than grade WS – the second of the seven-level-scale - decreased significantly with increasing avalanche danger (Fig. 3, left). No significant differences in route difficulty could be noted between groups of different group sizes.

The proportion of reports, which stated that the summit was not reached increased significantly with an increase in avalanche danger ($p<0.001$, Figure 3 right), a decrease in weather (fine weather 6%, poor weather 13%) and an increase in route difficulty, and was independent of gender, avalanche education (mountain guide or volunteer tour leader, other users) or group size.

6. CONCLUSIONS

We investigated a large multi-annual dataset of backcountry touring activities and compared these to backcountry touring avalanche accidents. For the first time, we used activities posted on social media mountaineering websites to analyze winter sport backcountry patterns.

The usage data from the social media networks showed plausible results and was comparable to actual counts of recreationists in backcountry terrain (Zweifel and Wäger, 2008; Procter et al., 2013). However, as only a fraction of backcountry users reports their tour on the internet, this study cannot investigate the absolute avalanche risk.

The number of backcountry recreationists and avalanche accidents was greatest on weekends with fine weather conditions. During more critical avalanche conditions there were proportionally fewer activities, but more accidents. Hence, the odds of being involved in an avalanche accident increases from one danger level to the next.

Backcountry recreationists adjusted their summit goal and selected route depending on the conditions. However, as proposed by Hendrikx et al. (2013), more objective data is needed to investigate human behavior in avalanche terrain.

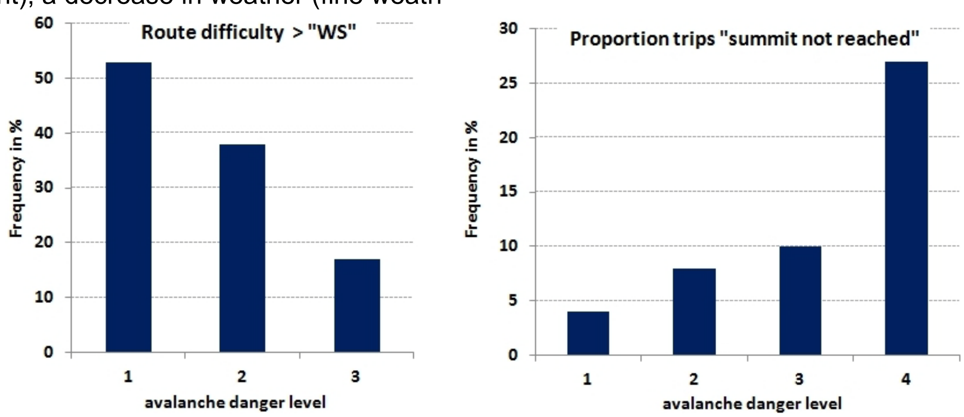

Figure 3: Frequency of route difficulty higher than WS (“wenig schwierig” = “little challenging”, mean 33%, left plot), and the proportion of trips, where the summit was not reached (mean 8%, right plot), by forecasted danger level.

Looking at the patterns of backcountry usage, avalanche-warning services should make an increased effort to communicate the warning prior to fine weather weekends and holidays to increase the awareness of the current avalanche danger and avalanche problem – of course, without taking the expected higher risk into account in the danger assessment.

ACKNOWLEDGEMENTS

We thank camptocamp for the permission to use their data (creative commons licences *CC-by-sa* (Camptocamp, 2014b) and special permission to use *CC-by-nc-nd* content). Also, we thank the rescue organizations Rettungsflugwacht Rega, Kantonale Walliser Rettungsorganisation KWRO-OCVS, Air Glaciers und Air Zermatt and all the numerous SLF observers and employees, avalanche rescuers and backcountry recreationists who reported and collected accident data. Stephan Harvey and Jürg Schweizer provided helpful comments which greatly improved this manuscript.

REFERENCES

Camptocamp (2014a) (online: http://www.camptocamp.org/articles/107675/en/help-guidebook-grades-for-ski-touring-ski-mountaineering-and-snowshoeing, 07.05.2014)

Camptocamp (2014b) (online: http://www.camptocamp.org/articles/106728/en/license-of-the-contents , 22.07.2014)

Crawley, M. (2007) The R book, JohnWiley and Sons Ltd., 1st Ed., 2007.

Grímsdóttir, H. and McClung, D. (2006) Avalanche risk during backcountry skiing – An analysis of risk factors. Natural Hazards, 39(1): 127-153

Harvey, S. (2002) Avalanche incidents in Switzerland in relation to the predicted danger degree. In: Proceedings International Snow and Science Workshop, 2002, Penticton, B.C.

Hendrikx, J., Johnson, J. and Southworth, E. (2013) Understanding travel behavior in avalanche terrain through combined use of GPS tracking, logbook records, and in-depth interviews. In: Proceedings International Snow Science Workshop 2013 Grenoble - Chamonix Mont Blanc.

Jamieson, B., Schweizer, J. and Shea, C. (2009). Simple calculations of avalanche risk for backcountry skiing. In: Proceedings International Snow Science Workshop Davos.

McCammon, I. and Haegeli, P. (2004) Comparing avalanche decision frameworks using accident data from the United States. In: Proceedings International Snow Science Workshop 2004. Jackson, WY.

Munter, W. (1992) Neue Lawinenkunde. Ein Leitfaden für die Praxis. 3x3 Lawinen. ISBN 3-85902-116-8. SAC-Verlag, Bern. 2nd Ed.

Munter, W. (1997) 3x3 Lawinen. ISBN 3-76332-060-1. Agentur Pohl und Schellhammer, München, Germany. 220 pages.

Procter, E., Strapazzon, G., Dal Cappello, T., Castlunger, L., Staffler, H. P., & Brugger, H. (2013) Adherence of backcountry winter recreationists to avalanche prevention and safety practices in northern Italy. Scandinavian Journal of Medicine & Science in Sports. doi: 10.1111/sms.12094

Pfeifer, C. (2009) On probabilities of avalanches triggered by alpine skiers. An empirically driven decision strategy for backcountry skiers based on these probabilities. Natural Hazards, 48(3): 425-438

SAC (2012) SAC Schwierigkeitsskala für Skitouren. (online: http://www.sac-cas.ch/unterwegs/schwierigkeits-skalen.html, 07.05.2014)

Schweizer, J. and Lütschg, M. (2001) Characteristics of human-triggered avalanches, Cold Reg. Sci. Technol., 33, 147–162.

SLF (2013) Avalanche Bulletins and other products. Interpretation Guide. Edition 2013. 13th revised edition. WSL Institute for Snow and Avalanche Research SLF. 50 p.

Techel, F. and Zweifel, B. (2013) Recreational avalanche accidents in Switzerland: trends and patterns with an emphasis on burial, rescue methods and avalanche danger. In: Proceedings International Snow Science Workshop 2013. Grenoble - Chamonix Mont Blanc. 1106-1112.

Zweifel, B. and Wäger, P. (2008) mal10hoch-5. Bergundsteigen - Zeitschrift für Risikomanagement im Bergsport. Oesterreichischer Alpenverein, Innsbruck, Austria, 17(1): 40-44.

Zweifel, B., Techel, F. and Björk, C. (2012) Who is involved in avalanche accidents? In: Proceedings International Snow Science Workshop 2012, Anchorage, AK