RANGE-SPECIFIC AVALANCHE EDUCATION

AN ARGUMENT FOR THE INCLUSION OF REGIONAL CONCERNS IN BASIC AVALANCHE COURSES

Philip Straub*
Fairbanks, AK, USA

ABSTRACT: This writing is the product of a study which explores variability in snow avalanche dynamics between mountain ranges in the western United States and contemplates how this information can be applied in avalanche education. Official curriculum resources pertaining to specific mountain ranges are not currently available on a widespread basis for avalanche educators teaching introductory (Level I) classes. The study compiled known information on snow climates and the effects of many geographic variables to examine large scale spatial variability and related snow avalanche concerns. Mountain ranges in the western U.S. are divided into three snow avalanche climates: Maritime, Transitional and Continental (Mock & Birkeland, 2000). While these are generally accepted as defining avalanche character within large regions, this study further explores the differences between snow avalanche trends in individual mountain ranges, including research using backcountry avalanche accident statistics to examine how these differences apply to backcountry user groups. This research is applied to suggest that Level I avalanche classes should include information on the specific mountain range or region in which the course is taught, and that range-specific supplemental resources should be developed to be implemented in these courses.

KEYWORDS: avalanche education, Level I, range-specific, snow climate, spatial variability

1. INTRODUCTION

With the average annual number of avalanche accidents steadily rising (Tremper, 2008), user access to comprehensive avalanche education is vital. In the United States, various levels of avalanche training are available to the general public, ranging from introductory seminars to professional level science and forecasting courses. While it would make sense that an increase in the availability of avalanche education would reduce the number of accidents, an increasing number of victims have had some form of snow-dynamics or avalanche assessment training (Fredston, Fessler, & Tremper, 1994). With the majority of avalanche courses offered in the United States being of an introductory level (Avtraining.org, 2014), and the majority of avalanche accidents occurring in regions close to victims' homes (Tbl 1.), an increase in regional avalanche awareness would be a valuable addition to an introductory course. Although the curriculum for introductory avalanche courses employed by most organizations covers important foundational material, high variability in snowpack trends between mountain ranges suggests the need for regional data and concerns to be included in basic avalanche education. This is information which could save lives.

2. BACKGROUND

While extensive research has been done on the differences of snow and avalanche dynamics between mountain ranges, incorporating such information into introductory avalanche courses is only done on an unofficial basis. This section focuses on these differences and defines the most substantial factors in creating unique snowpack trends in specific ranges.

Range-specific disparity in avalanche trends occurs across all of North America as well as mountain ranges on all continents. Recognizing this, the focus of my research, and the entirety of this writing, is on mountain ranges of the western United States, including Alaska.

2.1 Snow Climates

Andre Roch first explored the interaction between geographical regions, snow climates and avalanche dynamics in 1949 (Lachapelle, 2001). Roch differentiated between multiple snow avalanche climates in the western United States, separating them based on their prevailing weather and topography (Lachapelle, 2001). Official research and data collection on snow climates was...
2.2. Avalanche Formation

Avalanches are primarily affected by weather and topography (McClung & Schaefer, 2006). All avalanches are created through an interaction between weather and terrain. People have a comparatively small impact on the creation of an avalanche, generally providing only the final trigger (Tremper, 2008). Slab avalanches are the most destructive form of avalanche and pose the greatest threat to winter backcountry travelers and are responsible for the majority of avalanche fatalities (Tremper, 2008). Because of their prevalence in avalanche accidents, slab avalanches are a major focus in Level I avalanche classes. There are four factors in the creation of a slab avalanche: slope of a certain angle, a cohesive slab of snow or ice, a weak layer of snow or ice beneath the slab, and a trigger to set the slab moving (Tremper, 2008). All four of these factors can be attributed to weather and topography (with the exception of artificially triggered avalanches including those started by people, when only the trigger is attributable to other factors). Because weather and topography are so closely related to avalanche formation, differences in these two important factors from mountain range to mountain range create variations in snow and avalanche trends between ranges (McClung & Schaefer, 2006)

2.3. Avalanche Education

This writing will reference Level I avalanche curriculum guidelines. Level I is a certification received by completing an introductory level avalanche course that is a total of twenty-four learning hours. The three major institutions that provide Level I courses are the American Avalanche Association (A3), the American Avalanche Institute (AAI) and the American Institute for Avalanche Research and Education (AIARE). These associations have similar standards for course material. While the required guidelines for such a course are not entirely universal and are up to the certified instructor or governing institution holding the class, most Level I classes in the United States cover similar material. A standard Level I course taken in the U.S. will cover the definition of an avalanche, weather, terrain, snowpack, avalanche rescue, and human factors (heuristic traps) that lead to most avalanche accidents (Avalanche.org, 2014; Avtraining.org, 2014). Most other organizations that teach Level I may use a curriculum either based on or directly from one of these major institutions.

3. SNOW AVALANCHE CLIMATES AND LATITUDE

3.1. North American Snow Climates

Snow climates are often discussed at some length in a Level I class. The western U.S. (including Alaska) contains three major snow climates: Maritime, Transitional, and Continental (Mock & Birkeland, 2000). It should be noted that these regional classifications do extend through western Canada, but these portions of the major snow climates are not addressed by this writing. Ranges with Maritime snow climates are located in proximity to the ocean or another major body of water and tend to receive large amounts of high density (wet) snow at regular intervals. Continental snow climates are far from the ocean and the mountains generally receive lesser amounts of low density (dry) snow at more sporadic intervals. Mountains with transitional snow climates are sandwiched between these two regions and display characteristics of both neighboring snow climates. Standardized predictions for the transi-
ional zone are difficult, but the mountains tend to receive moderate to large amounts of snow of varying density with some consistency. Transitional zones also tend to receive sporadic events of either inordinately high snowfall or prolonged drought.

Generally mountains within the same snow climate share more characteristics with other ranges within their zone than with mountain ranges in other zones. However, within each snow climate there is significant variability between mountain ranges, including important differences in weather and topography. Examining the snow climate where an avalanche class is taking place is a perfect opportunity for a situational exploration of what makes a snow climate unique. A further study of the weather and topography of the specific mountain range can display how large scale spatial variability exists in students’ regions. This can be a valuable component in defining the unique snow dynamics of students’ local mountains. Such knowledge could potentially reduce accidents among graduates of Level I courses.

3.2. Latitude and Snow Climate

Differences in latitude can have profound effects on snow avalanche dynamics. All latitudes in the contiguous American West are designated as regions of latitude where aspect is of the highest importance for avalanche formation (Tremper, 2008). Alaska lies outside of these latitudinal bounds, but these more extreme latitudes produce notable differences in snow dynamics, which are discussed below.

Snow climates in North America compress with increasing latitude. This is to say that the higher the latitude, the narrower each snow climate becomes (Tremper 2008). This means that a mountain region lying a certain distance from the ocean may be within a Maritime snow climate in the contiguous United States, but a mountain range of equal continentality in Alaska may exhibit a very continental snow climate. Additionally, some mountain regions in far northern Alaska do not conform to this limited zonal model and exhibit an arctic snow climate (Tremper, 2008). Winter recreation in these areas is extremely limited due to very low populations and the absence of light during the winter months, and discussion of these regions is beyond the scope of this writing.

The farther north a range lies, the quicker the lengths of days change in the fall and, perhaps most importantly, the spring. Because snow often destabilizes under rapid change, latitude should be considered when discussing insolation. Also, because of the difference in the angles of direct insolation based on latitude, different angles of slopes will receive more or less direct sunlight depending on how far north or south a range is located. The more southerly the mountain range, the more directly the sun will shine on less-steep southern slopes. Ranges further to the north will receive more direct sunlight on steeper south-facing slopes. Because the sun is one of the key components in the creation of dangerous weak layers and in the melting processes that often cause destructive wet slab avalanches (Tremper, 2008), understanding how the latitude of a mountain range effects its individual snow climate is important for understanding avalanches in a region, and could be valuable information when discussing snow climates during a Level I course.

4. SPATIAL VARIABILITY AND SCALE

4.1. Spatial Variability and Backcountry Travel

In avalanche studies, spatial variability describes the differences in snow between different locations and is quantified on multiple scales (Schweizer, Kronholm, Jamieson, & Birkeland, 2008). Three basic scales are used to describe spatial variability: synoptic (regional, e.g. a mountain range or series of ranges), meso-scale (a section of a range, e.g. a ski area) and micro-scale (a single feature, e.g. an avalanche path) (McClung & Schaerer, 2006). Before venturing into potential avalanche terrain, a winter backcountry traveler may research synoptic and meso-scale concerns. This can be done by obtaining a forecast from their local avalanche center (assuming one exists for the region) and a regional weather forecast. Previous knowledge of the area and the season’s snowpack are also examples of synoptic and meso-scale information. Micro-scale variability is encountered and assessed by looking at the layers in the snowpack and performing a handful of easy tests in the field (McClung & Schaerer, 2006). With this combined knowledge, final decisions are made about exposure to avalanches.

4.2. Applications in Avalanche Education

In a Level I avalanche class, the progression described above is often emphasized as part of a safe day in the backcountry. It is an effective technique when implemented correctly. If widespread avalanche danger is forecasted by the local avalanche center, a backcountry traveler may either choose to stay home for the day or to completely avoid avalanche terrain, making micro-scale snowpack variability an unnecessary part of stability assessment. In fact, localized assessment such as digging snow pits (also part of
a Level I curriculum) to assess avalanche danger for a specific run or feature is completely unnecessary if one never exposes themselves to avalanche terrain. While this type of avoidance is a technique that many people use, others may be unsatisfied with the limited terrain that this risk management option allows access to. Often, winter sports enthusiasts find avalanche terrain to be ideal for skiing, snowboarding, snowmobiling, climbing and other activities. When exposing oneself to avalanche terrain micro-scale assessment is an important tool which can help an individual make safe choices about where they choose to travel. Students who complete a Level I course are encouraged to use the covered information on micro-scale assessment and synoptic and meso-scale research to have fun and to make conservative decisions about entering avalanche terrain.

With this emphasis on the individual managing their terrain choices on a smaller scale, concerns of larger scale spatial variability are left up to avalanche professionals. This may result in people traveling in avalanche terrain with a diminished understanding of larger snowpack and avalanche trends in their region. Because Level I curriculum is relatively standardized and only covers the introductory topics that students need to make conservative decisions, further exploration of pertinent range-specific avalanche information is not a required component of curriculum, and may be left untaught.

5. AVALANCHE ACCIDENT STUDY

5.1 Goals

The goals of this study were to examine basic factors associated with avalanche accidents in the United States and to examine the relationship between avalanche fatalities and proximity to victims' homes. By examining trends in destructive avalanches, the study hoped to shed light on common differences between dangerous or deadly avalanches in different mountain ranges. The study addressed the distance of avalanche sites to victims' homes in an attempt to reveal trends in avalanche fatalities relating to a victim's access to the area in which the accidents occurred.

5.2 Methods

This study used publicly available data pertaining to avalanche accidents in the United States from ten seasons (2003-2013). These accident reports were obtained from an online database (Avalanche.org, 2014) and heavily favor accidents in which a fatality was reported. The study took place in two stages.

Data gathered for the first stage of the study included snow climate, state, mountain range, activity, weak layer, bed surface and numbers of people caught, buried, injured and killed. This was a simple compilation of information from each reported accident.

The second stage took a random sample of the compiled accidents and additionally noted the origin of the victim(s) and whether or not the accident occurred in each victim's home range, home state or home snow climate. For the purpose of this study, home range was defined as a location within 100 linear miles of the victim's place of residence. Much of this information was gathered from media reports pertaining to the individual accidents. After processing this data, the study more specifically examined chosen accidents involving fatalities.

It is important to note that this study did not include information about the level of education each victim had pursued or whether or not each victim received their avalanche education in proximity to their home range(s) or place of residence. This study recognizes that avalanche victims are increasingly those with a history of avalanche education (Fredston, Fessler, & Tremper, 1994), and assumes that this holds true for accidents examined. Also, the study assumed that most people seek out avalanche education as close to their home as possible. Because the study compiled information on location of each accident examined, and a majority of accidents occurred near locations where avalanche education is currently available, it has been assumed that a majority of the victims with avalanche training took their class(es) near their home and home range(s).

5.3 Results

This study produced information both about snow avalanche dynamics in specific mountain ranges and snow climates as well as data pertaining to avalanche fatality locations in relation to the origins of victims. This writing will focus on the most pertinent results for the goals of this study.

This first stage of this study found largely inconclusive results pertaining to weak layers associated with avalanche accidents within each snow climate. This is primarily due to the significant number of accidents in which the weak layer was not reported on the public accident database used by this study. Nearly 50 percent of the accident reports used did not mention the weak layer. While some trends in active weak layers in relation to snow climates were revealed in this study, the large potential margin of error due to the high percentage of unreported weak layers renders
this information irrelevant to this writing. Future inquiry with more comprehensive data may yield more conclusive results.

The secondary study of victim origin in relation to accident location was markedly more conclusive. This study showed that a large majority of avalanche fatalities occur in victims' home range(s) (Tbl. 1).

Tbl. 1: Prevalence of avalanche accident locations based on victim origin

<table>
<thead>
<tr>
<th>Accident Location</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Range</td>
<td>67%</td>
</tr>
<tr>
<td>Other Range</td>
<td>16%</td>
</tr>
<tr>
<td>Not Reported</td>
<td>17%</td>
</tr>
</tbody>
</table>

5.4. Study Conclusions

Because a majority of fatalities occur in mountain ranges close to victims’ homes, and because synoptic scale spatial variability between individual mountain ranges is widely accepted as having an impact on snow avalanche dynamics (Mock & Birkeland, 2000), the study suggests that the inclusion of range-specific avalanche concerns in basic avalanche courses would be beneficial in educating students in backcountry avalanche avoidance and mitigation. This range-specific information may include common weather patterns, slab characteristics and weak layers, as well as geography, popular terrain and travel techniques for nearby mountain ranges.

Although the information compiled on weak layers and resulting avalanches was inconclusive, a more focused study on a range-specific scale could be valuable in the production of range-specific resources for Level I classes pertaining to common weak layers and slab avalanche trends.

While this study has focused primarily on avalanches in the western United States and on introductory level education, it is the author’s opinion that the inclusion of this suggested information should be considered for avalanche classes of varying levels taught in other mountain ranges in North America and worldwide.

6. CONCLUSION

Neither mountain ranges nor avalanches are standardized. Avalanche education needs to include standardized information, but the replication of common curriculum to teach avalanche classes in a variety of ranges may omit important regional information. Level I avalanche courses convey the majority of information needed to make safe decisions in the backcountry. By addressing the larger topics in enough detail to be implemented further by students, the courses prepare graduates well for future backcountry winter adventures. However, because they follow a relatively standardized curriculum, there are few resources that accompany the curriculum that target range-specific avalanche concerns. Because of the wide variety in topography, climate and location among the mountains of the western United States, and because many avalanche accidents occur close to home (Tbl. 1.), omitting range-specific information leaves students with a diminished set of tools for their backcountry excursions. Including this range-specific information would be relatively simple, especially with the development of pre-existing resources and curriculum. Creating resources for range-specific avalanche education at the introductory level would be useful for students and educators alike in the important ongoing mission of reducing avalanche accidents.

REFERENCES


