TRAVEL ADVICE FOR THE AVALANCHE PROBLEMS: A PUBLIC FORECASTING TOOL

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ABSTRACT: The following paper presents a new public forecasting tool designed to communicate travel advice specific to each of the established Avalanche Problems. Avalanche Problems have become a mainstay, not only for forecast centers but also for avalanche education throughout North America. Among professionals, it is widely agreed that the type of avalanche conditions determines one's choice of terrain. Many of our users are only beginning to understand this concept. Therefore, we seek to expand the current descriptions by adding terrain management advice specific to each of the nine Problems. In order to accomplish this, a set of five metrics was established to determine each Problem's inherent manageability. Compiled into a short paragraph, the advice will be displayed in a pop-up window along with additional information including a photo, video, graphics and associated definition. The pop-up window will be accessed from the daily avalanche advisory webpage through a subscript 'i' hyperlink located near the icon(s) for the day's Problem(s). This paper concludes with a discussion of the many challenges encountered.

KEYWORDS: Avalanche Problems, terrain management, travel advice

1. INTRODUCTION

Ten years ago Rodger Atkins presented his avalanche characterization checklist that sought to "summarize the complexity behind stability evaluations in a manner that is meaningful for backcountry terrain selection" (Atkins, 2004). In short, mitigating risk by matching one's terrain to the type of avalanche expected. A few years later, driven by this concept, the Utah Avalanche Center (UAC) drafted a similar set of avalanche threats to use in their daily advisories. Debuting in 2008 on the UAC forecast webpage were the avalanche threats (which are now referred to as Problems) and accompanying icons, which are still used today.

During the last several years the Problems have been adopted by many other avalanche centers in the United States and Canada. Definitions for the Avalanche Problems in the United States were developed by a working group during the summer of 2012 and overseen by the National Avalanche Center. These can be found at: http://utahavalanchecenter.org/avalanche-problems-tutorial.

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Although the Avalanche Problems are relatively new, their use in public advisories has been acknowledged to improve avalanche safety (Klassen et al. 2013). An additional advancement in avalanche public safety is the recent revision of the North American Danger Scale (Statham et al. 2010a). Two of the major developments with the revision were (1) the classification of 'avalanche character', which is in line with the Problems, and (2) the addition of travel advice for each danger level, influenced by avalanche character (Statham et al. 2010b). Considering this, it follows that travel advice could be tailored to each of the Avalanche Problems.

Therefore, the essence of this project is to attempt to craft travel recommendations specific to each Problem. The overarching goal is to improve forecaster communication, via website avalanche advisories, of terrain management guidance to recreational users and hence public safety.

2. MOTIVATION

The motivation for this project stems from the evolution of the Avalanche Problems becoming the standard method avalanche forecast centers use in their advisories each day. In turn, the Avalanche Problems have become a mainstay for avalanche education throughout North

America. Among professionals, it is widely agreed that the avalanche conditions - that is, the overall danger as well as the particular kind of avalanche one expects, determine one's choice of terrain. This is the essence of safe travel in the mountains - the Holy Grail of matching one's terrain to the snowpack. Many of our Tier 1 and Tier 2 users are only beginning to understand this concept. Thus, we sought to create a fairly universal tool that forecast centers could use along with the Avalanche Problems to assist the public in making appropriate terrain choices.

3. METHODOLOGY

We wanted the travel recommendations to be **simple, useful, and easily compared based upon a parallel structure of a narrowed-down set of metrics**. The five metrics, shown in the bullets below, were determined by the authors to have the greatest influence on terrain selection.

Terrain management metrics:

- Predictive snow behavior (manageability/certainty)
- Destructive potential
- Spatial distribution
- Potential for remote triggers
- Reliability of obvious clues and stability tests

We have attempted to use these metrics in order to divide the Problems into two groups (Normal Caution and Extra Caution) based upon what we would call their inherent "manageability", or lack thereof. Manageability is well aligned with the overall degree of certainty (and again, lack thereof) of what can be referred to as "predictive snow behavior". It is also aligned with the user's skill/experience and overall size of the avalanche.

Two groups based on inherent manageability:

- Normal Caution
  - Usually predictable snow behavior
  - Manageable
  - Certainty
- Extra Caution
  - Usually unpredictable snow behavior
  - Unmanageable
  - Uncertainty

All things being equal, we classified each Avalanche Problem according to its *general characteristic* for each of the five metrics (Tbl. 1). Subsequently, we used this set of terrain management metrics to group the Problems into either the Normal Caution or Extra Caution categories (Tbl. 2). This was, of course, a challenging task due to the complexity of snow behavior.

Tbl. 1: Avalanche Problem general characteristics associated with each metric.

Avalanche Problem	*Predictive Snow Behaviour*	*Destructive Potential*	*Spatial* Variability	*Remote Trigger Potential*	*Reliability of Field Tests*
Storm Snow	High	Low/High	Widespread	Low/High	High
Loose Dry	High	Low	Widespread	Low	High
Wind Slab	High/Low	Low/High	Widespread/Localized	Low/High	High/Low
Persistent Slab	Low	High/Low	Localized	High	Low
Deep Slab	Low	High	Localized	High	Low
Loose Wet	High	Low/High	Widespread/Localized	Low	High
Wet Slab	Low	High	Localized	Low/High	Low
Cornice	High/Low	Low	Localized	Low	Low
Glide Slab	Low	High	Localized	Low	Low

Tbl. 2: Avalanche Problem groupings: Normal Caution vs. Extra Caution.

Normal Caution	*Extra Caution*
Loose Dry	Wind Slab
Loose Wet	Persistent Slab
Storm slabs	Deep Slab
Cornice	Wet Slab
	Glide Slab

5. PRODUCT AND IMPLEMENTATION

5.1 *Travel Advice*

By condensing the information in both Tbls. 1 and 2, we have developed a set of 'travel advice' phrases for each Problem. Slope angles were chosen with a conservative approach and based upon preliminary research by McCammon (2009). His work included start zone steepness differences by avalanche type and weak layer grain type. After much discussion and feedback, from both professionals and recreationalists alike, several different variations emerged. The versions we have to date are shown in Tbls. 3 and 4. These are living documents and modifications, i.e. using a bulleted format, may evolve.

5.2 *Metric Graphics*

Currently work is being done to develop graphics for each of the five metrics that will accompany the travel advice. There will be one graphic for each metric. The graphic will have a 'speedometer with dial' appearance that will indicate a certain Problem's general character for that metric. For example, the Loose Dry graphic for remote triggering will have the dial pointing toward 'low' potential for remote triggering.

Tbl. 3: Travel Advice for Avalanche Problems categorized as Normal Caution.

Avalanche Problem	*Travel Advice*
Loose Dry	**Avalanche conditions associated with usually predictable snow behavior.** Normal Caution is advised. Test slopes, snow pits, slope cuts, previous tracks, and cornice drops tend to provide some level of information on stability. **More prevalent on steep slopes at the higher elevations** (as depicted in the current avalanche forecast). **Avoid this terrain or choose slopes gentler than 40 degrees in steepness.** Give runout zones a wide berth when natural avalanches are expected or when others may be traveling above you.
Loose Wet	**Avalanche conditions associated with usually predictable snow behavior.** Normal Caution is advised. Test slopes, slope cuts, previous tracks, and cornice drops tend to provide some level of information on stability. **More prevalent on steep sunlit slopes** (or as depicted in the current avalanche forecast). **Avoid this terrain or choose slopes gentler than 40 degrees in steepness.** Give runout zones a wide berth when natural avalanches are expected or when others may be traveling above you.
Storm Snow	**Avalanche conditions associated with usually predictable snow behavior for experienced snow travelers.** Normal Caution is advised, yet will increase with significant new snow accumulation. Test slopes, snow pits, slope cuts, previous tracks, and cornice drops tend to provide some level of information on stability. **More prevalent at the higher elevations on all aspects** (as depicted in the current avalanche forecast). **Avoid this terrain or choose slopes gentler than 35 degrees in steepness.** Give runout zones a wide berth when natural avalanches are expected or when others may be traveling above you.
Cornice	**Avalanche conditions associated with usually predictable snow behavior.** Normal Caution is advised. **Prevalent along the ridgelines** at the mid and higher elevations on particular aspects (as depicted in the current avalanche forecast). **Cornices may release on approach. Avoid traveling along corniced ridgelines, as cornices may break back further than expected.** Avoid traveling through terrain with significant cornices above. Give a wide berth when natural cornice fall is likely, when cornice fall may trigger avalanches below, or when others may be traveling above you.

Tbl. 4: Travel Advice for Avalanche Problems categorized as Extra Caution.

Avalanche Problem	*Travel Advice*
Wind Slab	**Dangerous avalanche conditions associated with higher levels of predictable snow behavior for experienced snow travelers.** Extra Caution is advised. Test slopes, snow pits, slope cuts, previous tracks, and cornice drops tend to provide some level of information on stability. **Typically confined to particular aspects and elevations** (or as depicted in the current avalanche forecast). **Avoid this terrain or choose slopes gentler than 35 degrees in steepness.** Give runout zones a wide berth when natural avalanches are expected or when others may be traveling above you.
Persistent Slab	**Dangerous avalanche conditions associated with unpredictable snow behavior.** Extra Caution is advised. **These are best managed through avoidance.** Test slopes, snow pits, slope cuts, previous tracks, and cornice drops are unreliable. Typically confined to particular aspects and elevations (as depicted in the current avalanche forecast). **Avoid this terrain or choose slopes gentler than 30 degrees in steepness with nothing steeper above.** Remote triggering possible, even from the valley below. Give runout zones a wide berth.
Deep Slab	**Dangerous avalanche conditions associated with unpredictable snow behavior**. Extra caution is strongly advised. **These are best managed through avoidance.** Test slopes, snow pits, slope cuts, previous tracks, and cornice drops are unreliable. Typically confined to particular aspects and elevations (as depicted in the current avalanche forecast). **Avoid this terrain or choose slopes gentler than 30 degrees in steepness with nothing steeper above or adjacent to you**. Remote triggering is possible, even from the valley below. Give runout zones a wide berth. **Due to potential size, traumatic injury, deep burial or death is likely.**
Wet Slab	**Dangerous avalanche conditions associated with unpredictable snow behavior.** Extra Caution is advised. These are best managed through avoidance. Test slopes, snow pits, slope cuts, previous tracks, and cornice drops are unreliable. **More prevalent on the sunlit aspects** (or as depicted in the current avalanche forecast). **Avoid this terrain or choose slopes gentler than 35 degrees in steepness with nothing steeper above.** Remote triggering possible, even from the valley below. Give runout zones a wide berth. **Due to potential size, traumatic injury, deep burial or death is likely.**
Glide Slab	**Dangerous avalanche conditions associated with unpredictable snow behavior.** Extra Caution is advised. These are best managed through avoidance. Test slopes, snow pits, slope cuts, previous tracks, and cornice drops are unreliable. Typically confined to particular aspects and elevations (as depicted in the current forecast). **Avoid this terrain or choose slopes gentler than 30 degrees in steepness with nothing steeper above.** Give runout zones a wide berth. **Due to potential size, traumatic injury, deep burial or death is likely.**

5.3 *Implementation via pop-up window*

Displayed in a pop-up window, the advice will be accompanied with the associated Avalanche Problem icon, a photo, a video, graphics for each of the five metrics in Tbl. 1 and the official National Avalanche Center definition. The pop-up window will be accessed from the daily avalanche advisory webpage through a subscript 'i' hyperlink. The hyperlink will be located near the icon(s) for the day's Problem(s). We would like to make it clear that this product is not intended to overwhelm the current forecast page; rather provide easy access to additional information for the person who seeks it.

6. DISCUSSION

It is no surprise that many questions and concerns arise with attempting to categorize the Avalanche Problems within these five sets of metrics and subsequent groups of inherent manageability.

Wind slab, for instance, poses a particular challenge considering it can easily fit in either Normal Caution or Extra Caution depending on slab thickness and hardness. Another concern exists with different user groups, specifically motorized vs. non-motorized. Is it possible these two user groups could have different travel advice for the same Problem? And finally, one of the big discussions during the feedback process: manageability. We use the term 'inherent manageability' in this project, yet what does the word really communicate? How is it perceived from person to person and how does that impact decision-making in the backcountry? These are just a few examples of the many conundrums encountered when trying to fit a dynamic medium into a box. Yet, all things being equal and generally speaking, most of us would likely agree that we travel quite differently in avalanche terrain on a considerable day for loose dry snow and shallow storm slab avalanches compared with the same danger for deep slabs. This is the essence of what we are trying to convey to the reader searching for a bit more to supplement what is written in the forecast.

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