Ski / Sled tracks as an expression of avalanche risk

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www.montana.edu/snowscience/tracks

Majestic HeliSki, Alaska
(Hank de Vre Photography, 2014)
Decision making

• We take a geo-spatial approach to understand avalanche risk.
• Travel in backcountry avalanche terrain is a classic example of decision making in a high risk / low probability settings.

• Here is another example:
  • https://www.youtube.com/watch?v=baVPKqBydro
“Top of the cliff”

• Most accident analysis looks at the result.
  – i.e. When the risk margin was exceeded

• Our approach is trying to understand the reasons and the patterns of risk behavior

• Result in targeted education
Overview

• Risk is a function of:
  – Probability – Function of terrain and snow conditions
  – Consequence – Function of terrain
  – Exposure – Function of terrain
  – Vulnerability – Not terrain (transceivers, airbags etc)
  – Decision making – Function of group / gender / etc / ???

• **If the snowpack is your problem = terrain is the solution**

• Ski / sled tracks as geographic expression of risk
Overview

• Safe winter backcountry travel is the effective reduction of risk, and is a combination of:
  – Education, experience, judgment & technology

• Trip information that documents all of this is largely anecdotal or nonexistent.

• In many cases, despite reasonable knowledge of the snowpack, people are still having accidents due to poor decisions / poor risk management.
Crowdsourcing tracks in 2013/14 (and 14/15 → 15/16)

- Crowd-sourced data collection campaign:
  - Use a smartphone application called SkiTracks to track people more easily and enable rapid sharing of data.
  - Smartphone optimized survey tool to allow for easy and rapid completion of the daily post trip survey.
  - Expand pilot study and more heterogeneous group

- We collected hundreds of tracks and survey responses from all around the World:
  - USA, Canada, Norway, France, Slovakia, New Zealand
Understanding Travel: A Crowd Sourced Approach

Contact Information:
Email: tracks@montana.edu
Website: http://www.montana.edu/snowscience/tracks

Overview:
This project aims to collect GPS location information to support decision-making. Our focus is on collecting data from participants to contribute to this research.

Participation:
If you are interested in taking part in this project, please follow the easy steps below (or download this PDF):

1. Sign-up to participate
   www.surveymonkey.com/s/PreseasonParticipantSurvey

2. Download “SkiTracks” by CoreCoders
   App Store
   Google Play

3. Track your trips
   Send your GPX file to: tracks@montana.edu

4. Automatic reply
   Autoreply from tracks@montana.edu with link to post-trip survey

5. Complete a short, post-trip survey
   www.surveymonkey.com/s/daytripsurvey

More information:
If you want to learn more about our project aims, research questions and approaches, please visit our web pages:
www.montana.edu/snowscience/tracks

Or scan our QR code:
Ski Tracks

- Smart phone based application to track your trips
- Easy tracking (Cell or GPS)
- Optimized battery usage
- **Easy sharing!**
- Accepted **GPX** files from other sources
- Emailed to tracks@montana.edu
Tracks

Terrain Metrics

Pre-Season & Post-trip survey

Decision making

Jordy Hendrikx & Jerry Johnson
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Colorado

- Moderate Hazard
- Solo traveller
- Intermediate
Alaska

- Moderate Hazard
- 3 Males
- Intermediate
- Moderate Hazard
- 5 Males
- Mostly Experts
- Low Hazard
- 2 Males
- Both Experts
- Moderate Hazard
- 1 Female / 1 Male
- Both Experts
- Cons. Hazard
- 9 Male / 1 Female
- Mostly Experts
- Dark!?!?
Teton Pass, Wyoming

Hundreds of people!! That’s why we live in AK and MT!!
Data Analysis

- Data grouped by:
  - Group / Gender
  - Experience
  - Forecast
  - Problem
  - Region

- Compared to terrain metrics
  - Slope / aspect / ridge / curvature

<table>
<thead>
<tr>
<th>Group</th>
<th>Solo</th>
<th>3 Males</th>
<th>5 Males</th>
<th>2 Males</th>
<th>Male / Female</th>
<th>9 Male / 1 Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience</td>
<td>Int</td>
<td>Int</td>
<td>Expert</td>
<td>Expert</td>
<td>Expert</td>
<td>Expert</td>
</tr>
<tr>
<td>Max Slope</td>
<td>33.4</td>
<td>35.5</td>
<td>31.7</td>
<td>43.0</td>
<td>39.0</td>
<td>42.7</td>
</tr>
</tbody>
</table>
Results - Who

• WHO:
  – Male (84%) aged 26-35 (40%)
  – Has a bachelor’s degree+ (79%)
  – Employed full time working 40 or more hours per week
  – Has no children
  – Participated in other outdoor sports, e.g. hiking, downhill skiing, mountain biking, trail running and rock climbing.
Results – Group vs Terrain

• Gender:
  – Some evidence to suggest that gender is important
  – All male groups used much steeper terrain (i.e. greater exposure) than all female groups.

• Avalanche Forecast:
  – Steeper terrain used under LOW hazard.
  – *No difference* in terrain used between Moderate, Considerable and High hazard
Results - Terrain

• Terrain use in detail (2 days by Expert):
  – Same slope angles on LOW and CONSIDERABLE
  – Mitigated by Aspect
Results – Group vs Terrain

• Experience:
  – Majority identified as Experts (53%) & Intermediate (43%)
  – Statistically significant difference between Experts and Intermediates:
    • 30 years of skiing (Experts) / 20 years (Intermediate)
    • Terrain management skills
    • Level of avalanche education

• Group:
  – Weak evidence to show that group size is important.
  – Bigger groups on steeper terrain
  – 26% of all data from solo travelers – ALL EXPERTS
Results – Experience vs Terrain

• Terrain Usage:
  – Statistical differences between Experts and Intermediates:
    • Steepest terrain used
    • Length of trip
    • Duration of trip
  – Expert BC travelers expose themselves to more severe terrain.
  – Also have higher levels of avalanche education, experience, better decision making, and self assessed levels of avalanche terrain management ability.
  – Evidence of risk homeostasis?
Skiers compared to sledders
Skiers compared to sledders

- Number of avalanche fatalities in the US by activity (CAIC, 2015)

![Avalanche Fatalities Since 2000](chart)

- Backcountry Tourer: 116
- Snowmobilers: 161
Skiers compared to sledders

• Sledders cover way more terrain than skiers!
• Sledders are in much more avalanche terrain than skiers!
• But do they?
  – Depends on how you think about this.
  – Certainly more terrain
  – But more avalanche terrain?? …. Maybe not…
Skiers compared to sledders

- Red = Not visible
- Green = visible
- Large periods of time riders were not visible to one another.
  - Vulnerability
  - Consequence
Skiers vs Sleds

- Sled tracks – x10 to x40+ longer
- Generally on lower slopes
- Generally less % of track in avalanche terrain
- But on more features than skiers.
- Exposure a function of the # of “chances” on individual features
- Consequence & vulnerability a function of visibility

Terrain Metrics

95th
Heli-skiing

• Heli-ski guiding = prime example of high stress, high consequence decision making in avalanche terrain.
• Heli-skiing is an exciting experience
  – But also results in a high pressure scenario that demands consistently high quality decisions by guides and operators to mitigate avalanche risk
• Terrain is key to mitigation!
Heli-skiing

- We used GPS tracking of heli-ski guides to enable quantification of terrain use. Four questions:
  - Use of lower (or higher) slope angles or different aspects, under higher avalanche hazard conditions or specific avalanche problems?
  - Variation in terrain use (i.e. slope and aspect) between different lead guides when working with similar groups under the same conditions?
  - Do guides who ski with the same group over time shift terrain use (i.e. familiarity)
  - Can these changes in terrain preferences, if evident, be seen at differing scales of terrain usage?
Heli-skiing

• When we consider the data from 18 days of heli-ski guiding and look at terrain metrics by groups as defined by:
  – (1) the avalanche hazard; (2) the avalanche problem (3) the lead guide; or (4) the number of days skiing with a group,

• Do not observe any strong statistically significant differences between the slopes or aspects used
  – ?? Is there really no difference in terrain usage by a lead guide on a low hazard day, compared with a considerable hazard day ??
It all comes down to scale!
Heli-skiing

- No difference in terrain metrics when considered for an entire day under varying circumstance
  - **BUT:** Differences when the SAME terrain was considered under varying conditions
  - Highlights the opportunity for heli-ski companies to move around within permit area to still ski steep lines!
  - Reminds us that safe travel in a winter backcountry setting is a game of small scale thinking about the immediate terrain.
  - Potential to use method for internal / external auditing
Conclusions

• Risk is a function of:
  – Probability
  – Consequence
  – Exposure
  – Vulnerability
  – Group decision making

• Consider our ski / sled tracks as geographic expression of risk
  – *If the snowpack is your problem = terrain is the solution*
  – Tracks are often influenced by factors which include group size, gender, experience, and motivations rather than just snow stability and terrain.
Conclusions

• Crowdsourcing data collection was fairly successful:
  – Showed that methods can collect meaningful data
  – Terrain analysis relatively simplistic, but showed results based on a number of groupings.
  – Need resources and time to develop smarter terrain algorithms & mine our survey data more deeply.

• We have also applied methods to other settings:
  – E.g. Tracking Heli-Ski Guides – could provide a means of tracking / auditing (internal / external)?

• BUT - Overall we need more DATA!!
Global data collection 2015/16

• **WE NEED YOU!**
  • We hope to collect hundreds, maybe thousands of tracks from all around the World for this season
  • Sign-up and participate
  • Let others know!

**Sign up:**
www.montana.edu/snowscience/tracks
Acknowledgments

- All of our volunteers that tireless tracked their ski tours and completed their surveys.
- We also want to thank Mazamas and Montana State University for research grants to support the pilot study.
- Montana State University Undergraduate Scholar Program for supporting Ellie Southworth & Kyla Sturm to help with the data analysis.
- Black Diamond Equipment for spot prize donations for the 13/14 and 14/15 season.
MSU Snow Avalanche Workshop “MSUSAW”

- November 11, at MSU in Bozeman.
- FREE to all
- Topics include:
  - Trip planning and communication (Kirk Bachman);
  - Digging (Doug Chabot); Backcountry Panel;
  - Snow-up close (Prof Ed Adams); BC Medicine and avalanche accidents (Nadia Kimmel); Industry Panel.

- Please register:
  www.montana.edu/snowscience/workshop/index.html
Human Factor 2.0

• Multi-media production by Powder Magazine and Black Diamond:
  – Decision making
  – Consequences
  – Risk / Reward / loss
  – Case studies

http://features.powder.com/human-factor-2.0/chapter-1
Questions?

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