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To:
Heather Woods (CP)
Ian Tomm and Rob Rohn (HeliCat Canada)
Joe Obad and Aaron Beardmore (Canadian Avalanche Association)
Gilles Valade and Kevin Seel (Avalanche Canada)
Gord Ritchie and Bruce Jamieson (Avalanche Canada Foundation)

RE: 2015/16 Supporter Update of SFU Avalanche Research Group

1 Purpose of document

The purpose of the document is to inform the supporters of the Simon Fraser University Research Chair in Avalanche Risk Management about the activities accomplished between September 1, 2015 and April 30, 2016 and to provide a brief outlook on the planned activities for the next six months.

2 Team

For the 2015/2016 academic year, the core SARP team consists of the following personnel:

- Dr. Pascal Haegeli (team leader)
- Dr. Scott Thumlert (postdoctoral fellow funded by Mike Wiegele Helicopter Skiing through the MITACS Elevate Program).
- Reto Sterchi (PhD student)
- Bret Shandro (MRM student)

To further strengthen the link between SARP and practitioners, I have been able to get Dr. James Floyer (Avalanche Canada) and Grant Statham (Parks Canada) appointed as Adjunct Professors in the School of Resource and Environmental Management at SFU (final approval

pending). This arrangement allows James and Grant to officially serve on the supervisory committees for my students.

3 Research activities

3.1 General activities

During the first two terms, my activities were mainly focused on:

Building research infrastructure

This primarily relates to the development of database servers that are capable of safely storing data collected by our research group and collaborating partners and software systems to effectively interact with this data.

Establishing research collaborations

Due to the interdisciplinary character of the planned research, having research collaborators with relevant skill sets is critical for the success of my research program. I have been able to establish connections in various fields including statistics, cognitive psychology, climate modelling, geographic information science and others. These connections will be instrumental for developing solid analysis methods and effectively guiding my students.

Internal capacity

I have also focused on developing an effective and motivating work environment for my team by training students in relevant technologies, introducing them to key stakeholders and industry partners, and building a team approach.

3.2 Data collection

During the 2015/2016 winter season, the data collection efforts of SARP expanded on the GPS skiing tracks pilot study of 2014/15 and continued with the collection tracks in collaboration with mechanized backcountry skiing operations. This data will provide the foundation for research projects examining how the physical risk from avalanches is managed through terrain selection. Seven operations participated in this data collection efforts during the 2015/16 winter season:

- CMH Galena
- CMH Revelstoke
- Mike Wiegele Helicopter Skiing
- Monashee Powder Snowcats
- Northern Escape Heliskiing
- Selkirk Tangiers Helicopter Skiing
- Whistler Heliskiing

As of May 1, 2016, the complete dataset consists of roughly 2,650 tracked guide days including slightly **more than 20,000 ski runs** under a wide variety of conditions. Much of my time has been spent on optimizing the algorithm that properly extracts the GPS tracks from the raw GPS data files. The track data are complemented by avalanche safety observations (weather, snowpack and avalanche observations), operational assessments (e.g., conceptual model of

avalanche hazard, run lists) and information on operational constraints (e.g., flying conditions, skiing quality) that the collaborating operations have agreed to share with SARP.

An **online viewer** was developed to provide collaborating operations with direct access to their own GPS tracks. This viewer will provide an effective platform for discussing terrain and terrain selection with guides and operators in a tangible way.

4 Research projects

The current research focus of SARP is in the areas of avalanche hazard assessment and risk mitigation through terrain selection. Since last September, SARP has been pursuing three different research projects.

4.1 Quantitative assessment of conceptual model of avalanche hazard (Bret Shandro)

Using bulletin data from Avalanche Canada (since 2009/10) and Parks Canada (since 2012/13), Bret Shandro is quantitatively examining the components of the conceptual model of avalanche hazard (Statham et al., under review) with a special focus on avalanche character types. He is examining differences between seasons and forecast regions and, if promising, he will also explore the link between the observed patterns and El Niño/La Niña.

The expected results and benefits of this research include:

- A better understand of the relationships among the components of the conceptual model of avalanche hazard
- Foundation for modelling avalanche hazard
- A possible avenue for developing seasonal avalanche hazard forecasts
- Foundation for examining the effect of climate change on avalanche hazard

4.2 Professional terrain preferences for managing the physical risk from avalanche in mechanized backcountry skiing operations (Reto Sterchi)

Reto Sterchi's project aims to comprehensively describe how terrain selection at different scales is used in mechanized backcountry skiing operations to keep the physical risk from avalanches at an acceptable level. Reto will work closely with collaborating guiding teams to characterize their skiing terrain in a way that facilitates the extraction of meaningful temporal and spatial patterns at different scales and identification of the underlying decision rules.

The expected results and benefits of this research include:

- Capturing of existing operational expertise
- Foundation for the development decision aids for operational terrain selection (e.g., run lists based on historic choices under similar conditions in the past)
- Tangible terrain knowledge base for training new guides
- Foundation for the development of evidence-based terrain guidance tools for recreationists

4.3 Spatial terrain classification based on revealed preferences of professional mountain guides

Scott Thumlert's project is also using the GPS track data to examine guides' terrain choices, but he is using a slightly different analytical approach. Projecting the available ski tracks onto raster data that describes the local terrain characteristics (e.g., incline, aspect, curvature, forest density, etc.), Scott is trying to develop an algorithm to programmatically classify avalanche terrain into avalanche terrain exposure scale (ATES) type classes based on the 'most advanced' terrain guides are willing to ski under different levels of avalanche hazard. Scott's work will primarily focus on data collected at Mike Wiegele Helicopter Skiing.

The expected results and benefits of this research include:

- Quantitative, representative of terrain choices by professional mountain guides.
- Stepping stone for the development of computer generated terrain classification.

5 Outreach

5.1 Peer-reviewed publications

- Statham, G., Haegeli, P., Greene, E, Birkeland, K., et al. (under review) The conceptual model of avalanche hazard. *Natural Hazards*.
- Haegeli, P., & Pröbstl-Haider, U. (in press). Research on personal risk in outdoor recreation and nature-based tourism. *Journal of Outdoor Recreation and Tourism*.
- Garner, J., Haegeli, P., & Haider, W. (in press). The effect of heads-up-display (HUD) goggles on skiing and snowboarding speeds. *Journal of Outdoor Recreation and Tourism*.
- Johnson, J., Haegeli, P., Hendrikx, J., & Savage, S. (in press). Accident causes and organizational culture among avalanche professionals. *Journal of Outdoor Recreation and Tourism*.
- Haegeli, P., & Schweizer, J. (2015). Recent developments in applied snow and avalanche research. *Cold Regions Science and Technology*, 120, 153-156.

In final preparation

- Van Tilburg, C., Zafren, K., Grissom, C., Haegeli, P., et al. (in preparation). Wilderness Medical Society Practice Guidelines for Prevention and Management of Avalanche and Non-Avalanche Snow Burial Accidents. *Wilderness and Environmental Medicine.*
- Thumlert, S. & Haegeli, P. (in preparation). Terrain classification - an avalanche risk management tool. *Cold Regions Science and Technology*.

5.2 Other publications

- Haegeli, P. (2016). The new Research Chair in Avalanche Risk Management at Simon Fraser University. The Avalanche Journal, Volume 110.

5.3 Presentations

- Conlan, M. 2015. Goals and objectives of GPS tracking study. Selkirk Wilderness 2015 Guides' Training in Meadow Creek on Dec. 12, 2015 (presentation on behalf of Scott Thumlert). Audience: approx. 15 professionals.
- Thumlert, S. 2015. Introduction of SARP and GPS tracking study. Selkirk Tangiers Heliskiing 2015 Guides' Training in Revelstoke on Dec. 11, 2015. Audience: approx. 35 professionals.
- Haegeli, P. (2015). Effectiveness of avalanche airbags. Media launch of ArcTeryx Voltair avalanche airbag on Dec. 7, 2015 in North Vancouver. Audience: 12 global ski journalists and bloggers (fully funded by ArcTeryx).
- Haegeli, P. (2015) Introduction of SARP and GPS tracking study. Whistler Heliskiing 2015 Guides' Training in Whistler on Dec. 4, 2015. Audience: approx. 25 professionals.
- Thumlert, S. (2015). Introduction of SARP and GPS tracking study. Mike Wiegele Guides' Training in Blue River on Dec. 2, 2015. Audience: approx. 45 professionals.
- Haegeli, P. (2015). Introduction of SARP and GPS tracking study. CMH Guides' Training at the Adamants Lodge on Nov. 27 & 28, 2015. Audience: approx. 80 professionals.
- Haegeli, P. (2015) Effectiveness of avalanche airbags. Northwest Snow & Avalanche Workshop in Seattle, WA, on Nov. 8, 2015. Audience: approx. 450 recreationists (travel costs funded by Northwest Avalanche Center).
- Haegeli, P. (2015) Effectiveness of avalanche airbags. ArcTeryx Global Sales Representative Training in Vancouver, BC, on Oct. 14, 2015. Audience: approx. 350 ArcTeryx sales representatives (fully funded by ArcTeryx).
- Haegeli, P. (2015). Effectiveness of avalanche airbags. Colorado Snow & Avalanche Workshop in Breckenridge, CO, on Oct. 9, 2015. Audience: approx. 650 recreationists (travel expenses funded by Colorado Avalanche Information Center).
- Haegeli, P. (2015). The Canadian avalanche survival curve. Colorado Snow & Avalanche Workshop in Breckenridge, CO, on Oct. 9, 2015. Audience: approx. 650 recreationists (travel expenses funded by Colorado Avalanche Information Center).
- Thumlert, S. (2015). Intro to avalanche risk management. Breakfast Club of Calgary Business Network in Calgary on Oct 7, 2015. Audience: approx. 20 business professionals/recreationists.
- Thumlert, S. (2015). GPS tracking study. Breakfast Club of Calgary Business Network in Calgary on Oct 7, 2015. Audience: approx. 20 business professionals/recreationists.

5.4 Community outreach

- SARP Facebook page at https://www.facebook.com/avalancheresearch

5.5 Media coverage

- The press release of Simon Fraser University on Dec. 9, 2015 announcing the new research chair in avalanche risk management attracted considerable attention resulting in various articles being published including in the Province, the Vancouver Sun and numerous online news outlets.

- Numerous ski and backcountry blogs reported on P. Haegeli's research on avalanche airbags.
- The Globe & Mail published an in-depth article on the SFU Avalanche Research Program on February 19, 2016.

6 Other relevant activities

In the wake of the passing of my colleague and friend Wolfgang Haider, I have agreed to serve as co-editor-in-chief of the Journal of Outdoor Recreation and Tourism (JORT), a transdisciplinary, academic peer-reviewed journal focusing on any aspect of theory, method, or concept of outdoor recreation research, planning or management. Wolfgang Haider was the founding editor-in-chief of JORT.

My objective with JORT is to use this opportunity to establish a home for publishing interdisciplinary avalanche safety research that does not fit into the traditional outlets for avalanche research (e.g., Cold Regions Science and Technology) and to establish new connections with researchers working in other recreational fields.

7 Plans for near future

SARP has the following priorities for the summer 2016:

- Continuing work on active projects by students.
- Collaborating with partner operations to improve terrain datasets and develop meaningful research questions.
- Working on the four abstracts submitted to ISSW 2016.
- Designing and initiating new research projects in collaboration with stakeholders and supporters (e.g., accidents and incidents, economic impact of avalanche closures).
- Writing and submitting proposals to external funding agencies (e.g., NSERC, SSHRC, MITACS, PICS).
- Expanding functionality of online GPS viewer.
- Preparing for 2016/17 winter season.

8 Questions

If you have any question about SARP's research activities, please contact me anytime either by email (pascal_haegeli@sfu.ca) or phone (778-782-3579 or 604-773-0854).

9 Thank You

On behalf of my entire research team and SFU, I would like to thank all the supporters and collaborating operations for their support of the SARP research program. Our research would not be possible without your financial support and expert input to guide our program. We are grateful for this support and we are looking forward to a productive and long-term relationship between SARP and the Canadian avalanche community.