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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Exploring the relationship between avalanche hazard and large-scale terrain choices at a helicopter skiing operation – Insight from run list ratings" *by* Reto Sterchi et al.

Anonymous Referee #3

Received and published: 21 May 2019

General Comments: The authors present a study of the effect of avalanche hazard on run list terrain decisions from a helicopter skiing operation in northern Canada. From my knowledge, the statistical model chosen is appropriate. Overall, these terrain selection decisions of a helicopter skiing guiding team are complex and this paper provides the first meaningful insight into many of the relevant factors. Excellent work. While run list decisions are limited in their actual usefulness to understand guide's management of avalanche risk, as accurately detailed in the paper, they are an important part of the hierarchical decision-making process. This paper will help build the foundation for

future studies.

The main results show many expected patterns, and I am not aware of any other studies which provide this quantitative evidence of guide's decision-making.

Publication is recommended with revisions and some clarification.

Statistical model: Note, while I do have experience using logistic regression models and overall they seem appropriate for this analysis, I do not have sufficient expertise with these models to provide a meaningful evaluation of the applied model used in this study.

Specific Comments:

Title: Consider "Exploring the relationship between avalanche hazard conditions and run-list terrain choices at a helicopter skiing operation". A little shorter and the phrase "large-scale terrain choices" is ambiguous.

Page 1 Line 24-25: Please check if there is a more recent reference. Walcher et al. (under review) or Walcher (Master thesis) perhaps would be more appropriate.

Page 1 Line 27 - 29: Consider mentioning that operations use direct control of avalanche hazard through the use of explosives and strategic control of future avalanche hazard through "run maintenance" skier traffic.

Page 2 Line 3-5: General comment for reference, most mechanized guiding teams will produce the avalanche hazard forecast for the first run or two of the day rather than for the full day. i.e. "what is the avalanche hazard as we head out the door?". This hazard evaluation is then updated as new information is obtained throughout the day.

Page 2 Line 3 - 5: Consider adding brief details about 'avalanche problems' as these are more impactful on the run list than the avalanche hazard rating.

Page 2 Line 7: Please change "...open or closed for skiing with guests..." to "...open or closed for guiding with guests...". Note, disregard this if the specific operation (Northern

Escape) uses the stated nomenclature.

Page 3 Figure 1: Please add direction indication (i.e. north arrow) and coordinates.

Page 4 Line 1 - 8: Does NEH use yellow coding of runs that can be opened in the field after a specific condition has been confirmed? If so, could you comment on how this might affect the results of the study?

Page 5 Line 4: Delete "for a given path". Avalanche size classification relative to the path size is the US relative scale size definitions and the Canadian size definitions are referenced.

Page 5 Line 8 - 10: Consider deleting the sentence "While this hazard ... ". This is not directly relevant to the study and can be discovered through the references.

Page 5 Line 12 - 28: Please consider deleting these lines and re-wording. The background information on avalanche terrain classification, while interesting, is not very relevant. In my opinion, it would be more beneficial to focus on the methods used in this study to encode the runs and the benefits of these methods. The Wakefield et al., 2018; and Sterchi and Haegeli, 2019; studies are appropriate to describe and to describe how they were applied here in this study.

Page 6 Line 19 - 20: Please re-word or delete "or non-glaciated or glaciated alpine".

Page 6 Figure 2: Increase the size of the Figure with the aim to increase the font size. It is difficult to read the run labels.

Page 6 Figure 2 caption: Change the word "average" to "boxplots" or something similar that describes what data are shown.

Page 6 Line 18 to Page 7 Line 14: Consider using a table to describe the characteristics of the 6 classes of runs. Consider example photographs of the terrain from each code as these would greatly enrich the understanding of the terrain types.

Page 7 Line 9: Consider re-wording "Life-changing".

Page 8 Line 27: Page 4 Line 15 details that the CMAH uses nine avalanche problems. It appears as though you removed glide-slab problem from the analysis, which seems appropriate, however could you provide the rational for this?

Page 8 Line 31 -32: The CMAH specifies "unlikely" as the lowest likelihood term, how were avalanche problems assessed lower than "unlikely"?

Page 8 Line 29 - 31: This sentence is not entirely accurate. Size 1 avalanches are "relatively harmless to people", whereas Size 1.5 avalanches are not specifically defined and are somewhere between Size 1 "relatively harmless to people" and Size 2 "could injure, bury or kill a person". Further, the analysis would likely be more insightful with avalanche problems assessed with Size 1.5 avalanches included. The avalanche problem "Loose Dry" is often associated with smaller more predictable avalanching and often isn't assigned avalanche sizes larger than 1.5. Saying that, better insights into the "Loose Dry" avalanche problem will not substantially alter the results of the paper, so I leave it to the authors to decide whether to change the analysis.

Page 12 Figure 4: Label the X-axis and increase font size for the axes.

Page 12 Figure 4 caption: Add details that the x-axis represents the relevant avalanche hazard rating.

Page 18 Line 23 - 30: Inspecting Figure 5 for the run "Shrek", I do not observe the negative random intercept: it appears to be non-significant and slightly positive. It does appear to show significant positive OR for Deep Persistent Slabs and Persistent Slabs. Please explain.

Page 18 Figure 5: -Please increase font sizes as this figure is nearly unreadable. -Change the x-axis for "Relevant Avalanche Hazard Rating" to match the other formats. -Overall, I might challenge the authors to consider if there would be another graphical format that might convey the key points of this Figure more clearly and concisely. -One of the fascinating results from this plot is the increased variance in OR between

avalanche problems, for example the OR for each run under Deep Persistent Slabs and Persistent Slabs show much higher variance compared to the more predictable avalanche problems like Storm Slabs / Dry Loose / Wet Loose. The Relevant Hazard Rating also shows higher relative variance in ORs. - A very insightful set of results that are likely available with this dataset and analysis would be the relative difference of run coding probabilities between avalanche problems with increasing levels of avalanche hazard ratings. i.e., Produce Figure 4 graphs for grouped avalanche problems (Storm and Wind and Loose Dry, Persistent and Deep Persistent, Wet Slab and Wet) or each individual problem, and remove the recency of skiing on the runs classification.

Technical Corrections:

Page 3 Figure 1 caption: Delete "Geographical". It is obvious that it is a map.

Page 4 Line 5: Change "(i.e., the run is safe to ski with guests)" to "(i.e., the run is available to guide with guests)".

Page 4 Line 15: Delete reference"(Statham et al., 2018)". The CMAH has already been referenced.

Page 5 Line 21: Reword "at the runs scale".

Page 5 Line 33: Add "(2019)" after Haegeli.

Page 6 Line 1: Change "are" to "were"

Page 6 Line 6: Delete "(Sterchi and Haegeli, 2019)". The study has already been referenced.

Page 6 Figure 2 caption: Please confirm whether the Sterchi and Haegeli study is under review or has been published 2019, then update the manuscript accordingly.

Page 16 Line 12: Typo.. "the" should be "they".

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