Skitourenguru - Clarifications

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Abstract

Skitourenguru was invited in June 2019 to the 20th Conference of the European Avalanche Warning Services (EAWS) to present the project and its core component, the Quantitative Reduction Method (QRM). During the subsequent discussions some issues of common interest were raised. In the present document, the most fundamental issues are revisited and clarified. This document concludes that the challenges of tools like Skitourenguru lie first and foremost in the communication with the end-users.

1 The nature of the avalanche danger scale

Challenge:

"The avalanche danger scale is defined as a discrete variable. It is not allowed to introduce a new continuous parameter dependent on but different from the danger level."

Clarification:

The EAWS defines the avalanche danger scale as follows: *"The avalanche danger describes the likelihood of occurrence and the possible size of avalanches in a specific region of at least 100 km^2. The European Avalanche Danger Scale has five levels."* The SLF adds: *"The danger level is worked out on the basis of a range of variables, in particular the avalanche triggering probability, the prevalence of avalanche prone locations and the avalanche size"* [1].

All of the three properties that conform the danger level describe continuous phenomena. While the resulting danger level is classified in five levels it still describes a continuous phenomena. Correspondingly the Interpretation-Guide of the SLF [1] clarifies, that there are intermediate values between the danger level classes: *"Conditions change gradually rather than abruptly from one altitude zone to another resp. from one aspect to an other."*

In order to avoid high spatial sensitivities it's crucial to smooth out discrete danger level steps at warning region borders, at elevation thresholds and at aspect changes. Just think about a route following the border of two warning regions with different danger levels. The details of the smoothing as proposed by QRM are based on the best available knowledge and sensitivity considerations[2]. They may be discussed and improved for future versions. Omission of smoothing, however, would lead to systematic errors.

2 Applying the avalanche danger level to the single slope

Challenge:

"The danger level is only valid to an abstract warning region and therefore it's not admissible to project it to a single slope."

Clarification:

The spatial resolution of the danger level has a fundamentally different magnitude than the spatial resolution of the Digital Elevation Model (DEM). Whereas the danger level applies to an area of at least 100 km^2 [1], the cell's elevation applies typically to 100 m^2.

The danger level, however, carries information about the single slope: Each warning region is a collection of slopes. The danger level provides information about the avalanche situation in a warning region. From these two premises we can conclude: the danger level reveals information about individual slopes.

Figure 1 shows a phase model of a backcountry ski tour. Where the quantity and quality of information increases throughout the course of a backcountry ski tour (red line), the available options continuously decrease (blue line). In each phase the winter sportsman should use available information to support decisions upon available options. As seen in Figure 1, regional information is to be used before local information becomes available.

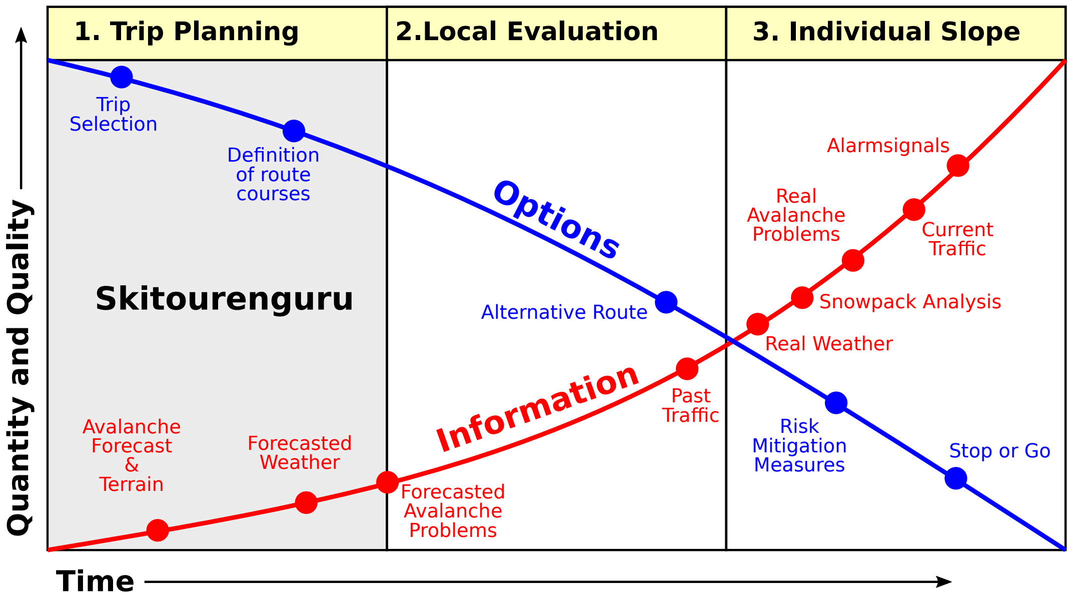

Figure 1: *The quantity and quality of information (red line) and options (blue line) during a backcountry ski tour. As time progresses one leaves the field of action and ends up in the field of reaction.*

3 Risk or Hazard

Challenge:

"The output of the QRM represents not risk, but hazard."

Clarification:
The Quantitative Reduction Method (QRM) results in compiled information that is relevant for planning ski tours. The information is presented in terms of a parameter that is called "relative risk" for a single point in the terrain and "risk indicator" for a route as a whole.

The definition of the terms "Risk" and "Hazard" is a topic of intense past and ongoing discussions among experts. So far consensus is reached only on rather generalised definitions, as standardised in e.g. ISO Guide 73:2009 [3], ISO 31000:2018 [4] and ISO 2394:2015 [5]: *"Risk is defined as the effect of uncertainty on objectives."*

The primary "objective" of Skitourenguru is to prevent backcountry skiers from triggering an avalanche and from being caught by an avalanche. This objective is achieved by taking into account the effects on the freedom of movement of the backcountry skier community.

A further differentiation of consequences (i.e. fatalities, injuries, material loss) following the triggering event is possible, but associated with many assumptions and therefore large uncertainties[6]. We believe ordinary backcountry skiers should avoid by all means to trigger an avalanche and to be caught by an avalanche.

Furthermore, "risk" is used in the leaflet "Caution Avalanches" [7] that summarises the current avalanche doctrine valid in Switzerland. It recommends the usage of the Graphical Reduction Method (GRM) during trip planning. The output of the GRM is defined as "risk". In order to be compliant to past and current naming conventions the QRM follows this example.

4 Data bias

Challenge:

"The GPS tracks provided by unknown contributors is subject to a participation bias".

Clarification:
Are the GPS tracks collected by Skitourenguru representative for the overall terrain usage of the backcountry skier community? Some insight can be given by a comparison to other datasets. Figure 2 compares the slope angle distribution of the GPS tracks to other datasets, like the Swiss Alpine Club route network [2]. If the GPS tracks had a strong bias, the slope angle distribution would differ significantly between the datasets.

Accident analysis that omits the travel usage of the backcountry skier community implicitly assumes an evenly distributed terrain usage. Figure 2 shows, that an evenly distributed terrain usage is unlikely. Accidents must be related to best available knowledge about terrain usage.

Additionally a sub-sampling test can be performed as follows: The GPS tracks are divided into two groups. A first group exhibits a median elevation gain of 846 m. The second exhibits a median elevation gain of 1542 m. The factor two between both groups reveals a huge heterogeneity within the contributor community. Nevertheless the QRM doesn't differ significantly, if derived from the sub-samples [8].

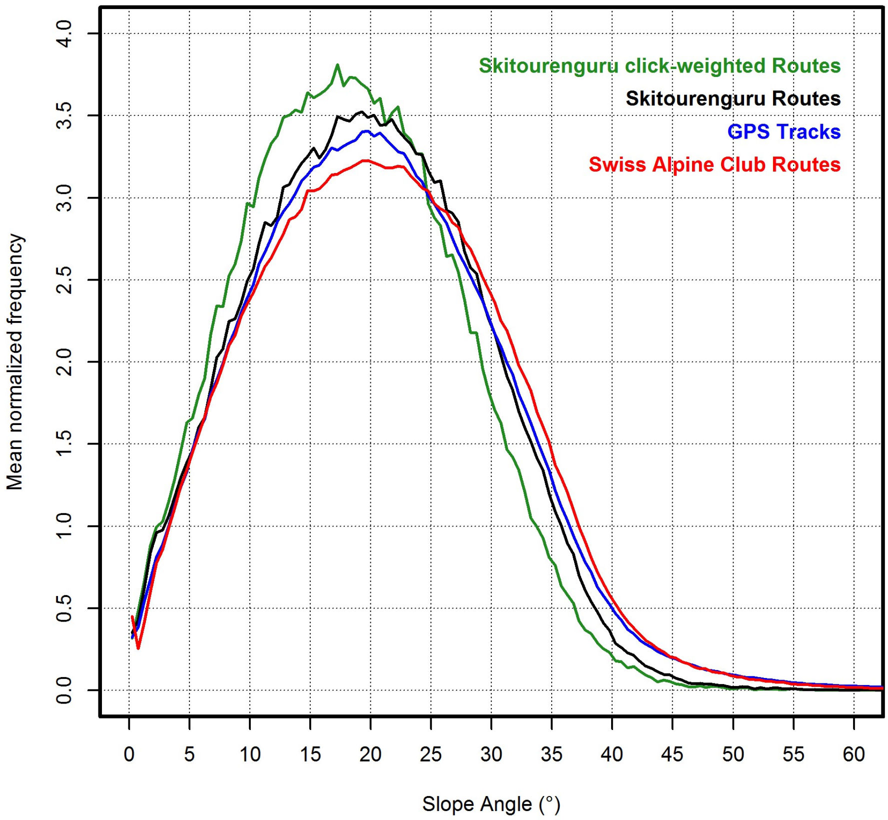

Figure 2: *The slope angle distribution of the GPS tracks, the Swiss Alpine Club Route Network and Skitourenguru Route Network.*

Conclusion

Even if the available information from the avalanche forecast doesn't meet our ideal, we are well advised to take it into account in our decision-making. We are convinced the challenges of applications like Skitourenguru lie first and foremost in the communication with the end-users. On one hand the enormous potential of advanced data analysis must be made available to end-users on the other hand its crucial that end-users are trained to understand the limits of new tools.

References

[1] Kurt Winkler, Thomas Stucki, and Jürg Schweizer. *Avalanche Bulletin Interpretation Guide.* WSL Institute for Snow and Avalanche Research SLF, 2018.

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[3] *ISO Guide 73:2009 - Risk management – Vocabulary.* International Organization for Standardization, 2009.

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[8] *Participation Bias.* `https://www.skitourenguru.ch/index.php/verifizierung/200-participation-bias`. Accessed: 2019-07-30.