TO GO OR NOT TO GO: DECISION MAKING AT INDIVIDUAL SLOPE

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ABSTRACT: The holistic assessment and decision framework «3 × 3» is well established for ski and snowboard tours. Whereas difficult decisions can be postponed in the first two filters, «planning» and «local evaluation», a final decision is necessary in the third filter «individual slope». At that point, we can only decide 'to go' or 'not to go'. So far, an approach asking the right questions and answering them systematically was missing. The latest edition of the popular leaflet «Caution Avalanches» now includes a risk-based scheme for decision making at the individual slope. Three elements of avalanche risk assessment are considered: the avalanche triggering probability, the consequences of being caught and the behaviour, i.e. measures to reduce the risk. Three colours (blue, pink and orange) corresponding to the three elements guide the user through the decision-making process. In a first step, important questions have to be asked related to each of these topics. The answers can then visually be combined with the help of a diagram to estimate the avalanche risk. The scheme suggests an explicit decision 'go' or 'no go' and helps not to forget anything essential. In addition to the established methods, such as the «graphical reduction method» or thinking in «avalanche problems», the presented tool is an aid to reflect important factors for making decisions at the individual slope. It especially applies to slopes steeper than 30° and to slopes that are either not obviously critical or unproblematic. We demonstrate how to apply this risk-based approach to make better decisions at the individual slope.

KEYWORDS: decision making, avalanche prevention, individual slope, backcountry touring, risk assessment, education

1. INTRODUCTION

The 3x3-framework (Munter, 1997) for assessing the avalanche hazard on tours in the winter backcountry is well established. Whereas difficult decisions can be postponed in the first two filters, «planning» and «local evaluation», a final decision is necessary in the third filter «individual slope». The evaluation and decision-making at the individual slope is based on the information from the planning as well as the own local observations during the tour. Various tools such as graphical reduction methods, risk assessment based on avalanche problems or a list of risk factors etc. support the assessment and decision-making (e.g. Harvey et al., 2012; Atkins, 2004; Haegeli, 2006). However, a systematic and risk-based approach for decision-making at an individual slope, focussing on the relevant questions and key factors is missing. Statham et al. (2017) propose a conceptual model of avalanche hazard for structuring the workflow for assessing avalanche hazard. This model is a logical and general framework focussing on avalanche forecasting, but is not a complete risk-based decision-making tool for backcountry tours. Hence, it must be adapted taking into account the consequences and terrain characteristics as well as behaviour. The presented tool is designed for risk-based decision-making at the individual slope within the 3x3-method and combines avalanche triggering probability, consequences and behaviour. It is included in the revised version of the leaflet «Caution avalanches» (Harvey et al., 2016).

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2. DECISION MAKING TOOL FOR INDIVIDUAL SLOPE

The presented tool (Fig. 2) focuses on slope areas that are typical cruxes and is primarily designed for situations that are not obviously critical or unproblematic - i.e. when decision making is difficult. It involves first assessing the probability of an avalanche, then the consequences of being caught by an avalanche and finally trying to minimise the risk with appropriate behaviour.

The colours "blue" (avalanche probability), "pink" (consequences) and "orange" (behaviour) guide through the decision-making process. Thereby, the questions in Fig. 1 are essential.

The scheme in Fig. 2 helps to combine the answers to these questions in a meaningful way and to make an informed decision without forgetting anything important.

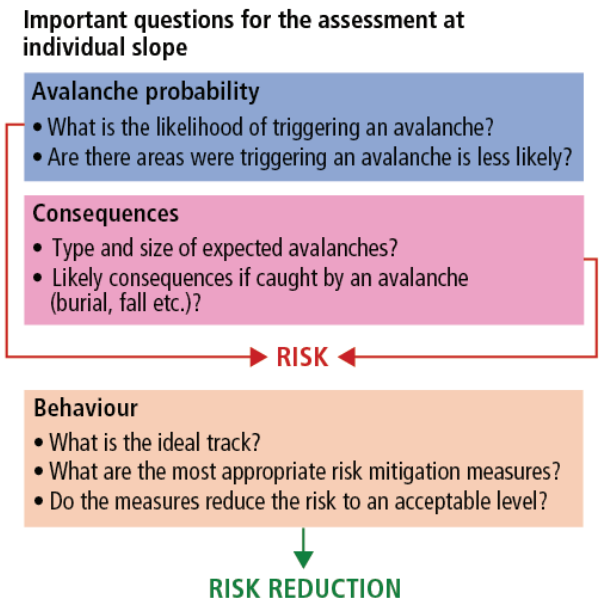

Fig. 1: These questions are essential when assessing the avalanche risk at an individual slope. They take into account avalanche probability, consequences and behaviour.

2.1 *Estimating the likelihood of an avalanche (blue)*

First, the area of the slope must be determined where an avalanche most easily could release and endanger the planned route. This can be an area with recent wind-loading or even the whole slope. Now the probability of triggering an avalanche must be assessed in the range of “low” to “relatively high” (Fig. 2). For the classification "low" a favourable situation is required. This can be a slope area where the snow has been eroded or where the snow cover may be considered as relatively stable due to clear indications. If there are obvious signs of avalanche danger, such as whumpfs, recent slab avalanches, recent wind slabs or if the critical amount of new snow is clearly reached, the avalanche probability must be classified as "relatively high". Before an overall assessment of the avalanche probability is made, both, the terrain in terms of avalanche release and the avalanche situation can be assessed separately first. The classification of the avalanche probability is not directly depending on the danger level as forecasted in the public bulletin. This means, that the avalanche probability on a specific slope can be assessed as “low”, e.g. when the slope is blown out, even when the predicted avalanche danger is “3: Considerable”. On the other hand, a “relatively high” avalanche probability can result when the slope has been recently loaded by wind, yet the avalanche danger was rated as “2: Moderate”.

2.2 *Assessing the concequences (pink)*

In addition to the avalanche probability, the consequences of being caught by an avalanche must be assessed. Relevant criteria are: Avalanche size (size of release area, expected fracture depth), terrain traps (danger of fall or burial) and the size of the group (number of exposed people). But how are the classes "+/-" to "---" (Fig. 2) to be understood? The class "+/-" means, it is highly unlikely that a complete burial or serious I injuries will occur. Yet, a twisted knee may be possible. If large burial depths or fatal injuries are to be expected, the situation is assigned to the class "---". Large groups or several people exposed contribute to higher consequences. This must also be taken into account.

Transferring the assessments for the avalanche probability and consequences into the diagram (Fig. 2) results in a risk assessment, split up in two groups – "Go/Go here" (accepted risk) or "No go" (risk too high).

2.3 *Reduce avalanche risk (orange)*

If the risk can be reduced, e.g. by selecting an optimal route and applying good tactics, a shift from the point in the scheme (Fig. 2) towards lower risk may be achieved. However, the risk can at most be reduced by the length of one square of the dashed grid (orange 90° sector). If the risk reduction measure only reduces the consequences, the direction of reduction is vertically downwards (e.g. travelling one at the time).

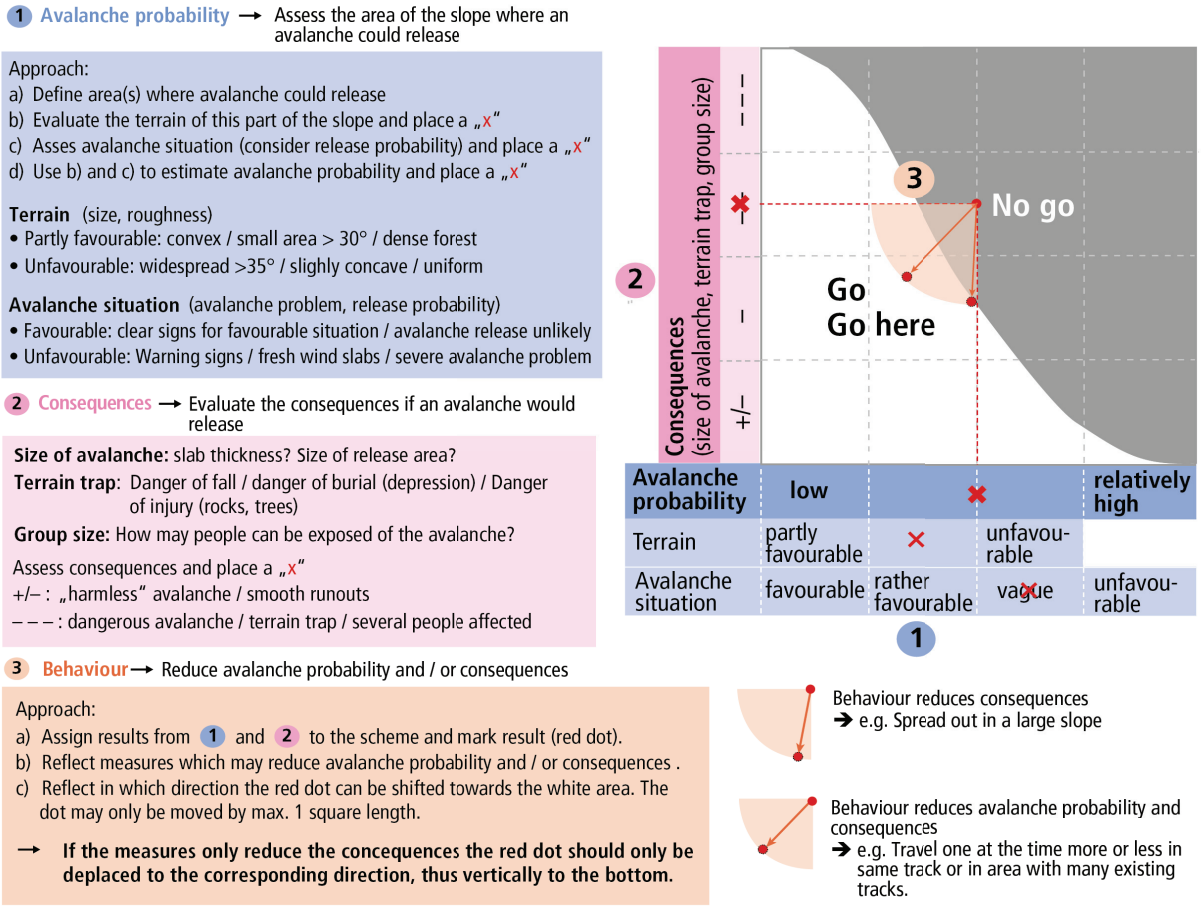

Fig. 2: Scheme and clues illustrating the decision-making process at an individual slope. First, the avalanche probability has to be assessed (blue). Second, the consequences of being caught by an avalanche are evaluated (pink). Third, the resulting risk can be minimised by appropriate behaviour (orange). The colours blue, pink and orange correspond to the important questions in Fig. 1.

Only if the behaviour also reduces the probability of triggering an avalanche, the point can also be shifted to the left (e.g. selecting lowest slope angles, choosing convex terrain or ski in recently tracked area). It is obvious that measures to reduce risk, such as travelling one at the time, may only be taken into account, if they have not already been considered while assessing the consequences.

3. APPLICATION EXAMPLES

The following two examples illustrate how the decision-making tool is applied in practice.

3.1 Case 1

A group of three backcountry skiers stands in front of the crux (Fig. 3) on a sunny day after a 20 cm snowfall and intermittently strong winds. Recent wind deposits can be recognized with a typical dune-like surface pattern. During the ascent up to this point no specific warning signs, such as whumpfs, shooting cracks or recent slab avalanches, were perceived and the avalanche bulletin predicts a danger level “2; Moderate”. The risk assessment using the scheme can be carried out in the following way:

Avalanche probability: The terrain can be described as unfavourable, since the slope is between 35 and 40 degrees steep, rather uniform and slightly concave. With regard to the avalanche situation, the signs of wind-drifted snow indicate an "unfavourable" avalanche situation, even so there are no warning signs and the danger level is “2; Moderate”. Overall, the avalanche probability must be assessed as "relatively high".

Consequences: The crux is not a pronounced terrain trap with a depression or rocks in the runout zone. The slope is running out gently, but large enough for a complete burial. The assessment of the consequences is approximately "--". The combination of these two assessments in the scheme ends up in the grey "No go" area. Even with appropriate behaviour, the risk cannot be sufficiently reduced.

If the wind-drifted snow is already three days old with no underlaying persistent weak layer, the avalanche situation is at best classified as

"rather favourable" (yellow cross in Fig. 3). The avalanche probability is then approximately in the middle of the scale between "low" and "relatively high". Although the consequences remain the same, the risk decreases, but the combination is still in the grey area. But now appropriate behaviour - e.g. keeping large distances – can reduce the risk towards the white area (yellow points in Fig. 3).

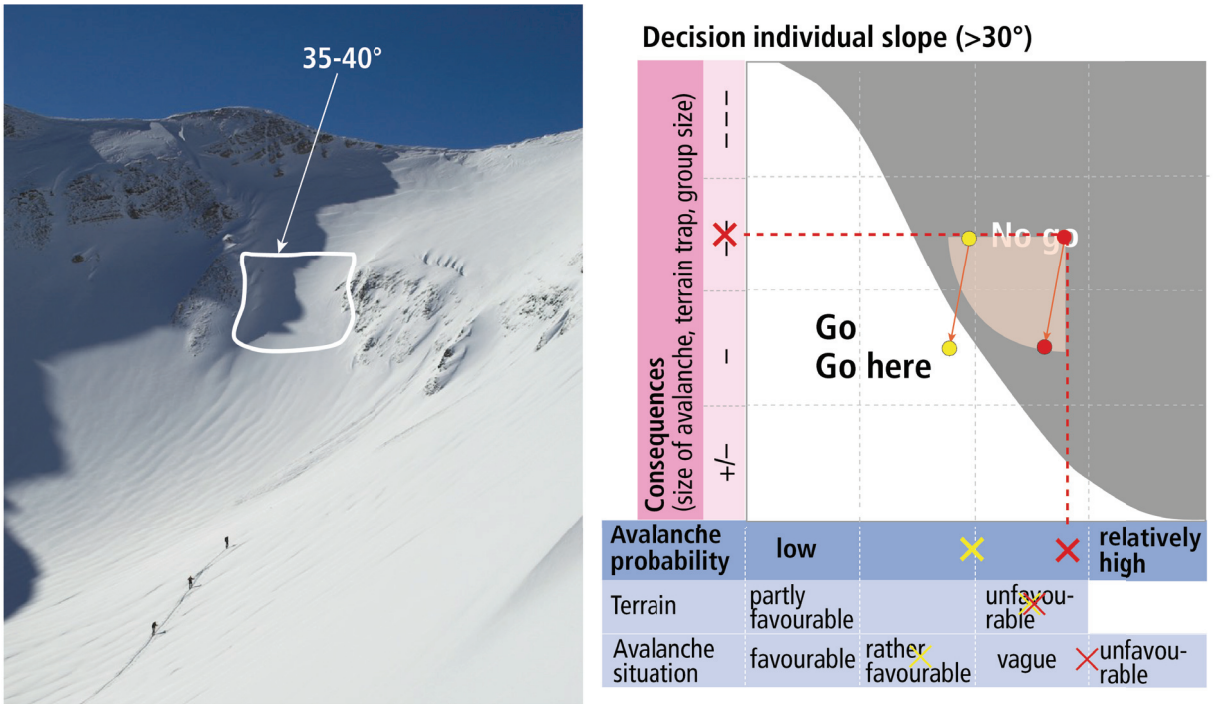

Fig. 3: Application example of using the decision-making tool for case 1.

3.2 Case 2

In the second example there are two cruxes which are similarly steep and similarly large. The first slope (yellow) has an irregular snow surface with an existing track and indicates variable snow cover conditions. We assume that the avalanche probability is approximately in the middle between "low" and "relatively high". Since the slope runs out rather gently and is not very large, the consequences can be classified between "-" and "--". The combination of the two assessments results in a point just at the limit (Fig. 4). Ascending along the existing track may reduce the probability of triggering an avalanche. In addition, further measures, such as keeping distances, can reduce the consequences as well. The yellow dot in the scheme can be shifted diagonally into the white area (accepted risk).

At the second crux (red), the snow surface indicates a more regular snowpack and therefore the avalanche probability is somewhat higher compared to the first crux. However, the consequences in case of an avalanche are more serious. There is a risk of falling over the rocks on the right as seen from below. For this reason, the consequences are classified as "---". Appropriate behaviour can hardly reduce the consequences, even less so the probability of triggering an avalanche. The red dot in the scheme must therefore be moved downwards. Because appropriate behaviour at this point only reduces the risk to a limited extent – a serious fall can hardly be prevented, it is appropriate not to use the reduction possibilities to the full extent, i.e. not to shift the red point by a whole square length. Thus, the red dot remains in the grey "No go" area.

The upper (red) crux is more delicate than the lower one (yellow).

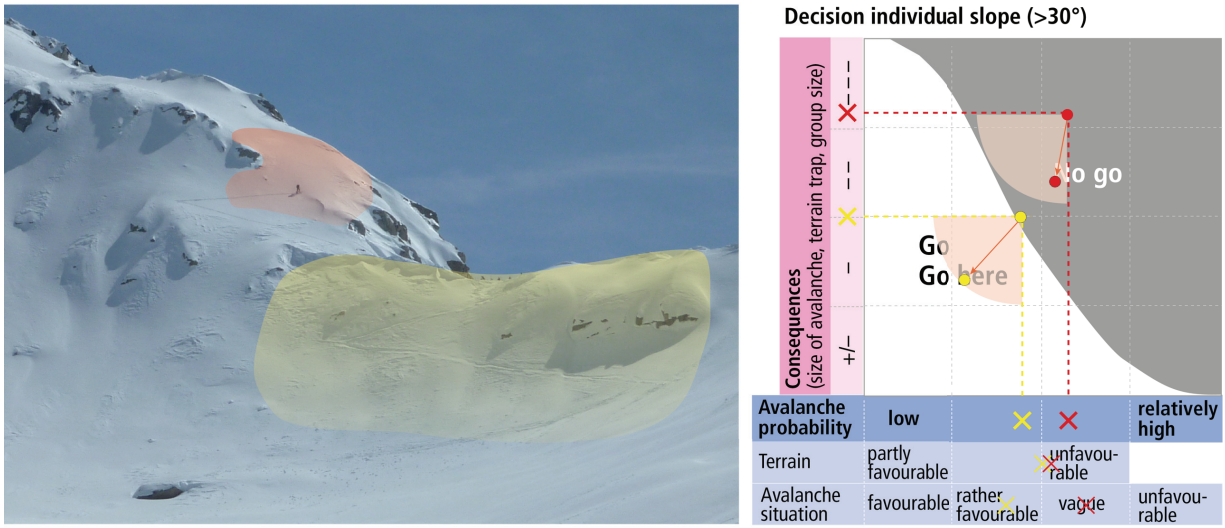

Fig. 4: Application example of the process using the decision-making tool for case 2.

4. CONCLUSIONS

The presented tool is an addition to the established methods, such as the «graphical reduction method» or thinking in «avalanche problems». It helps to structure the decision-making process and considers three elements of avalanche risk assessment: the avalanche triggering probability, the consequences of being caught and the behaviour, i.e. measures to reduce the risk. The focus is on the essential questions related to each of these topics (Fig. 1). Clues are provided to find answers for each key issue, which eventually are combined visually with the scheme (Fig. 2). Although the tool leaves some room for interpretation, it offers a systematic approach for decision-making at cruxes. However, everyone has to decide for themselves – depending on how much risk they are willing to accept given the responsibility they bear.

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