Practical risk assessment and decision making in avalanche terrain. An overview of concepts and tools in Switzerland

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ABSTRACT: Risk assessment and decision making tools for backcountry and off-piste skiing have changed time and again. Basic avalanche knowledge about the main avalanche forming factors has not changed essentially. But how to interact and how to deal with this knowledge in practice seems not to be as easy. Over the last 30 years decision making concepts reached from decision making with Rutschblock test to risk calculation on the basis of danger degree, terrain features and behaviour. In this presentation common tools are looked at from a practical point of view. It is important to focus on the main key factors. Therefore, pattern recognition plays an important role to consider "what is the main problem?" Some ideas for decision making are presented considering also human factors.

KEYWORDS: avalanche education, risk assessment, decision making, 3x3.

1 INTRODUCTION

In the past 30 years practical knowledge about avalanches has changed several times. Until the end of the 70-ties there was not much structure in assessing the avalanche danger. Decision making tools were inexistent. Practitioners knew roughly when avalanche danger was increasing (e.g. after new snow or strong solar radiation) and which areas were specially dangerous (e.g. slopes steeper than 30°). Mainly avalanche rescue und description of snow crystals were content of avalanche courses. However, consequences about behaviour in avalanche terrain were not derived. After the mid eighties Werner Munter described a structure to assess the avalanche danger. With this so called "3x3" method, the three factors conditions, terrain and human factor were combined and assessed at three different levels (preparation, assessment in terrain, individual slope). The decision on the individual slope was made based on the result of the Rutschblocktest. Hence practitioners had first of all a clear structure how to assess the avalanche danger, second a method to decide and third consequences followed from the decision. Although the decision method was educated, it was not used in practice. Digging Rutschblocks was first of all too time-consuming. Secondly, doubt on this method came up due to spatial variability. After a tragic avalanche accident occurred during an avalanche course in the Swiss Army, the Rutschblocktest was no more used as a single decision making tool. "Calculate instead shovelling" was Werner Munter's slogan since 1992 when he introduced his reduction method for avalanche awareness (Munter, 1997). His goal was to cut in half the number of avalanche fatalities. Thereby he drew on ideas of Vester (1978 and 1999) and weighted and combined important key factors in a formula. Hence the avalanche risk could be calculated in an easy way. Supporters of this method liked the simplicity, critics pointed to the dangerousness. To avoid seeming accuracy of the method, graphical versions of the reduction method were developed around the turn of the millennium dealing with bandwidth (Engler, 2001 und Harvey, 2000; Winkler 2006; Wassermann und Wicky 2003). On the basis of the original reduction method several modified versions were developed (e.g. "Bierdeckel", Stop or go, Limits, etc…). Application and education of these methods is different and controversial to this day. Different documentations for education, some unclearness concerning methods and some inconvenient consequences for behaviour exist. To avoid uncontrolled avalanche awareness a special core team for avalanche education was formed in 2005 (Rhyner, 2009). All important associations of snow sports in Switzerland attend this avalanche education core team. The goals are to coordinate, to harmonise and to advance methods, tools and documentation for avalanche education in Switzerland. Further more, this team organises special avalanche courses for instructors.

Thanks to close collaboration with the SLF, questions from practitioners can be transferred to scientists and results from science can be transferred quickly to practice.

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Recently a consensus was worked out among the members of the mentioned avalanche education core team to reduce the content of avalanche education to a common denominator for all sorts of education levels. This consensus is described in the following chapter. It forms the base of avalanche awareness in Switzerland.

2 CONCEPTS AND TOOLS

Decision making tools should not standardise making decisions, they should standardise the process of making decisions. Each backcountry and off-piste skier must make his own decision, according to his readiness to take a risk. Beginners with little avalanche knowledge make decisions with simple tools. Whereas, experts can judge sophisticatedly and use more complex tools for decision making. For all education levels the same system for risk assessment should be applied. However, the specific tools are used in a different way. In general the less knowledge, the simpler the tool and the smaller the range in avalanche terrain (Figure 1).

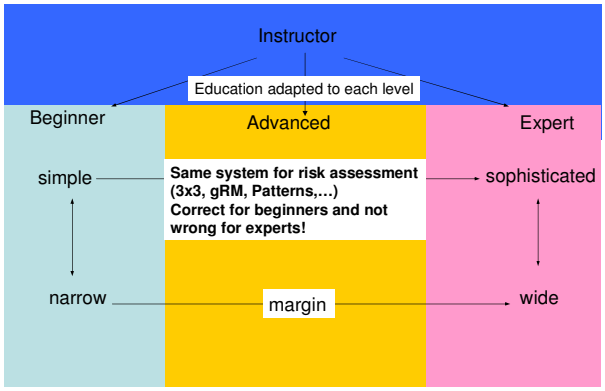

Figure 1. For all education levels the same system for risk assessment (3x3, gRM, patterns) is educated. The use of the tools is adapted for each level.

2.1 „3 x 3“-Method

The method “3x3” (Munter 2003) defines the frame which is used at all education levels (Figure 3). Within all 3 levels decisions have to be made. The focus in the “3x3” frame should be channeled on the main avalanche problem of the individual slope (from the preparation of the key passage to the assessment in the individual slope.

Experience can only expand if tours or descents are reflected after the event.

2.2 Graphic reduction method (gRM)

Among the various versions of reduction methods, in general we use the graphic chart within the “3x3”-method (Schweizer et al., 2005, Figure 2).

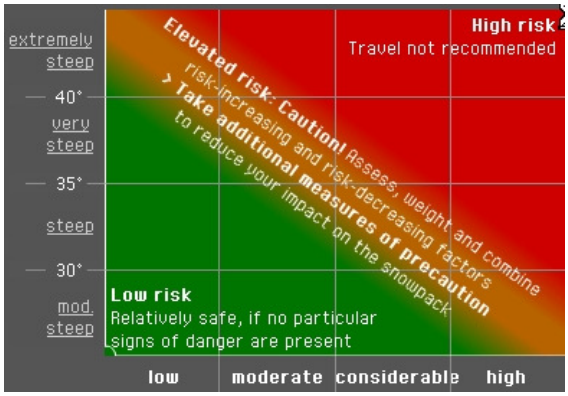

Figure 2. Graphic reduction method, which is generally educated in Switzerland.

The significance of the graphic reduction method decreases from the preparation to the individual slope in the “3x3”-method. This is meant especially for backcountry and off-piste skiers with advanced avalanche knowledge. For beginners the main judgment consists of avalanche danger level and slope angle. For them the graphic reduction method is crucial. At this education level the method is limited to the green area (Figure 2). Further, the steepest angle of the whole slope has to be considered from danger level 3 (considerable) on upwards.

Advanced recreationists should be able to distinguish the actual avalanche forming key factors and assess them according to the actual situation. If so, they have the knowledge to travel in the orange area of the graphic reduction method.

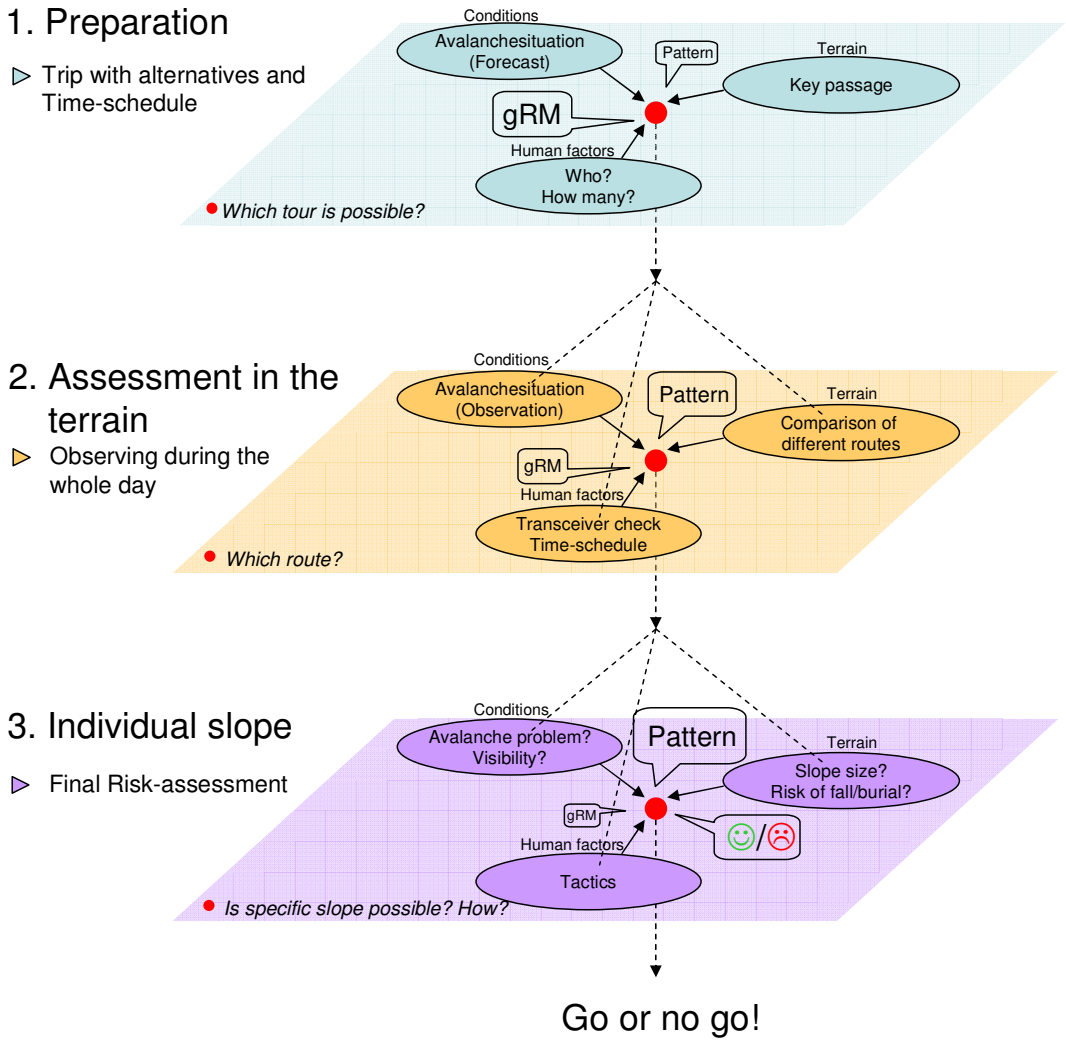

Figure 3. The "3x3"-method defines the frame for avalanche awareness in Switzerland. The significance of the graphic reduction method decreases from the preparation to the individual slope. The importance of pattern recognition increases.

2.3 Pattern recognition

Four typical patterns of avalanche danger help to diagnose and assess the avalanche situation and important key factors: new snow situation, wind slab situation, persistent weak layer situation and wet snow situation (Harvey 2008, Figure 4). Although each of these four patterns contains many variations, this first simple structure helps to focus on the actual main key factors. You can start looking for patterns already during a preparation of a route. However, the significance of this pattern recognition increases at the second and third level of the "3x3"-method (Figure 3). It helps the practitioner to answer the following question: What is the actual main avalanche problem at the moment? The importance of pattern recognition stands opposite the graphic reduction method. Thinking in patterns is especially useful for advanced backcountry and off-piste skiers as well as for experts. Therefore, example evaluation of the snowpack applies especially to persistent weak layer situations.

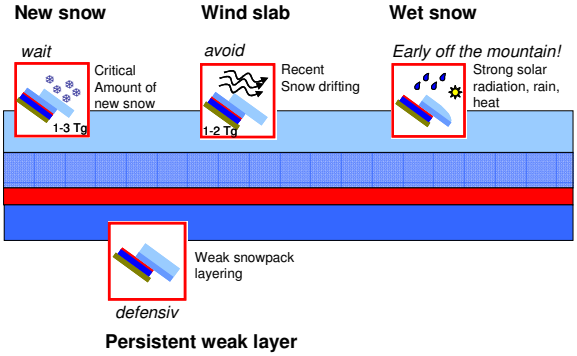

Figure 4: Patterns of typical avalanche situations. At new snow, wind slab and wet snow situations the avalanche problem results from external change on the surface of the snowpack. At persistent weak layer situations there is a problem further in the snowpack.

2.4 Snowpack tests

Thoughts about snowpack layering do not have to be associated with shoveling. Observation in the terrain (alarm signs, penetration depth, total snow depth, …), thoughts concerning the general course of the winter and information from the avalanche bulletin give valuable indication about the general buildup of the snowpack. Only plenty of thoughts and information about the snowpack allow a rough idea about the "blackbox" snowpack layering. If all the indications point in the same direction, it is easier to assess the layering of the snowpack than if the signs show different tendencies. The second situation makes the assessment of the avalanche situation more difficult and leaves it more and more to chance. In this case defensive behaviour is advisable. In practice no universal method for snowpack tests is used. Following methods are educated and more and more used by practitioners depending on the situation:

- Yellow flags (Schweizer et al., 2004)
- Compression Test (Jamieson, 1999)
- Extended Column Test (Simenhois et al., 2006)

2.5 Special tools for experts

An expert (e.g. mountain guide) should not be limited through education tools for risk assessment and decision making. These people do not have to consider the steepest part of the total slope at a considerable avalanche danger for example, if they can reason that remote triggering is unlikely. Also the red area of the graphic reduction method can be tolerable if there are enough risk reducing arguments. In Switzerland the original, so called professional reduction method, is educated to mountain guides. The margins of this method are wider for some situations. The "Nivo Check" (Munter 2007) is a checklist for experts to define or adapt a danger level on the basis of their observations.

4 DECISION MAKING AT INDIVIDUAL SLOPE

At the individual slope decisions like e.g. the slope can be skied or not, definitely have to be made.

The constitution of the snow, or the avalanche pattern respectively, combined with terrain features (slope angle, aspect, type, size) play an important role for avalanche triggering and risk assessment. Practitioners often use slope angle and danger degree for decision making. That means the probability of triggering is given by the danger level. However danger levels are rating the general avalanche danger in a region containing several slopes. A danger degree is a combination of trigger probability, spread of danger areas and size of expected avalanches (SLF, 2008). If small avalanches are expected, but the probability of triggering an avalanche is quite high, the avalanche danger can still lay at level 2 (moderate). Especially if there is a risk of fall this can lead to fatal and wrong decisions. A decision at a specific slope should be focused on the actual avalanche problem combined with terrain features. At the individual slope, reduction methods which strongly depend on a danger level should only be used marginally or with safety margins.

5 HUMAN FACTOR

With the 3x3 method the human factor has been identified as an important key factor in the whole risk assessment. However, especially risk reducing behavioural measures were the main human factor components. Psychological and social phenomena, which have an essential influence on decision making, have practically been neglected and hardly educated. Future case studies will sensibilise about the following typical human traps (McCammon, 2002):

- Commitment/wishful thinking
- Familiarity
- Exclusiveness
- Social recognition

Deciding rationally is not easy but essential in avalanche terrain. The nearly 25 year old creative technique called „six thinking hats" from de Bono (1986) has been educated and used in practice for the past 2 years. This method helps to decide objective and to break deadlocked patterns, perceptions and preconceptions.

6 CONCLUSION AND OUTLOOK

The assessment of the snowpack has been more and more emphasised whithin the past years. Simple and quick snowpack tests can give valuable information as long as they are not an exclusive criteria (Schweizer et al, 2004; Winkler et al, 2006; Harvey, 2006; Hoffmann, 2000). Pattern recognition helps structuring the assessment of the avalanche danger and helps to focus on the main avalanche problem (Harvey 2008). This structure supports the decision whether a snowpack test can be of additional value or not. Reduction methods are simple to use and useful to make an approximate risk assessment with the most

important key factors. Experts can evaluate the local danger degree with the checklist “Nivo Check” (Munter 2007). To be aware of human traps and to think objective is crucial when making the final decision.

The core team for avalanche education has defined a frame for the practical use and education of risk assessment and decision making methods for different education levels.

Further developments on decision making tools should focus on methods with recognition effect (Mersch 2007). Simple mental models concerning triggering and fracture propagation could make avalanche formation more comprehensible. It makes sense to separate danger levels from the individual slope. That uncertainty varies among different avalanche situations, has to be educated more clearly. Practical snowpack tests can still be optimised to achieve the best benefit with a minimum of work.

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