THE FIVE DECISIVE AVALANCHE PROBLEMS

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ABSTRACT: Making forecasts and compiling studies of hundreds of avalanches for 25 years have demonstrated one thing to us:

Avalanches are no coincidence. They are caused by systemic constellations. A combination of snowpack layering plus weather conditions is what leads to avalanches. Permutations are not numerous, patterns repeat themselves. The Avalanche Warning Service of Tirol has defined them: “The 10 Decisive Danger Patterns”.

This systematic road map of avalanches has been debated worldwide, it is a theme at conferences of Avalanche Warning Services. It appears that the Five Big Avalanche Problems will become the international standard.

The problems can be named: fresh-fallen snow, snowdrifts, wet snow, old snow, gliding snow. For each problem, a simple, instantly recognized icon has been designed.

‘Avalanche Problems’ and ‘Avalanche Danger Patterns’ have one thing in common: they point out intrinsic hazards, scenarios which are apparent to observers and which occur again and again.

The difference lies in what the crosshairs focus on. Whereas Avalanche Problems deliver a wide-angle snapshot, pinpointing sources of risk, e.g. snowdrifts, Danger Patterns delve into the moving details, outline a rising cause, e.g. loosely-packed new fallen snow plus stormy winds. Danger Patterns do not name hazards or describe backgrounds, they point to the unfolding process leading to avalanches.

‘Avalanche Problems’ are currently being introduced into the bulletins, feedback is positive. Their use permits graphic depiction of the overriding hazard in the headline, immediately graspable: WHAT is the problem (max.2), WHERE does it occur (altitude, aspect), WHY does it occur (danger pattern).

KEYWORDS: Danger Patterns, Snowdrifts, Gliding snow, Old snow, Fresh-fallen snow, Wet snow

1. AVALANCHE PROBLEMS, DANGER PATTERNS: A NEW APPROACH TO AVALANCHE SCIENCE

Each and every winter, we experts from the Avalanche Warning Service of Tirol work our way through intensive accident analysis when we stand before snow cavities where human beings have just lost their lives. Those situations make us think hard and feel deep, even more so when you realize that people walk into the same traps again and again.

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The reason for that? During the course of different winter seasons, a series of nearly identical avalanche scenarios take form which can be defined by so-called avalanche danger patterns (dp). The fundamental structure is always a combination of the snow layering at that moment and the immediately following weather which has a direct effect on avalanche formation. Experienced backcountry skiers can often (frequently unconsciously) call up such avalanche scenarios from their rich store of memories and adapt their conduct accordingly. But most freeriders and skiers in outlying terrain simply do not have the time to deal intensely and profoundly with the subjects of snow, weather and avalanches. For that reason, they tend to see only a landscape blanketed in snow without any awareness of the hidden dangers lurking inside it.

Those are the people who need assistance and support gained by reading avalanche warning bulletins and other sources of information, but above all else by becoming aware of the dp.

Umpteen analyses of accidents over the last twenty years have helped us to develop what at the outset was only a vague idea; then slowly evolved into loosely-linked associations of single dp's and ultimately climaxed in a mature system which runs like a red thread through the entire corpus of snow and avalanche science and is utterly cohesive and coherent.

1.1 The ten decisive danger patterns

We have selected 10 decisive dp's which in their sum represent at least ninety-eight percent of all the danger scenarios which occur during the course of one winter season. The essential characteristic of these patterns is their recurrence not merely within one winter season, but significantly, over the course of many highly varied winter seasons. In order to make the dp easy to recognize, we thought long and hard about their names, trying to give them monikers which are easy to grasp and remember. Ultimately, we decided on the following titles:

dp.1 weak ground layer from early winter

dp.2 gliding snow

dp.3 rain

dp.4 cold after warm / warm after cold

dp.5 snowfall after long period of cold

dp.6 loose snow and wind

dp.7 shallow snow zone encircled by deep snow zone

dp.8 surface hoar covered by snow

dp.9 graupel covered by snow

dp.10 spring scenario

1.2 Important classifications

Since the ten decisive dp's generally come about in certain time spans, it is simpler to recognize the relevant dp when it is placed in a time frame. For example, in high alpine regions dp.1 (weak ground layer from early winter) can occur as early as late autumn. Spring scenarios generally occur as of late February.

However, since we are dealing with Mother Nature, there are no rigid timelines for most of the dp's, but rather, shifting transitional phases and in isolated cases, rebellious exceptions to the rule. For example, when in deep winter (or even in early winter) springlike conditions suddenly occur.

Apart from a time frame, dp's can also be classifed spatially and geographically. Each dp occurs most often at specific altitudes and in specific aspects, to some extent even in specific regions. For example, dp.3 (rain) prevails to the same extent in all regions. Rain generally occurs below 2000 meters during the winter and has negative effects in all aspects. The scenario dp.5 (snowfall after long period of cold) which is invariably very critical leads to problems at all altitudes and in all aspects...but especially so on West-Southwest to North to East-Southeast facing slopes.

Something of particular interest to freeriders in outlying terrain: for generally a very short period of time in springtime, mogul ski slopes can trigger as slab avalanches. The reason for this is usually a thin, ground-level layer of depth hoar from early winter combined with a dense snowpack on top of it which is thoroughly wet.

2. AVALANCHE PROBLEMS

Avalanche Problems are the simpler, more superficial way of viewing avalanche dangers which threaten. Nonetheless, Avalanche Problems and Danger Patterns have one thing in common: each indicator calls attention to typical, generally obvious and recurring situations of peril.

The difference lies in the focus adjustment of each lens. Whereas Avalanche Problems provide an initial, brief, rough overview of potential sources of danger (for example, fresh-fallen snow), Danger Patterns look deeper into the situation, reach down until they touch the cause (for example, too heavy a burden of new-fallen snow on top of a weak layer). Thus, Danger Patterns define the possible scenarios and processes which lead to the creation of the relevant Avalanche Problem. You might say, one is the cause; the other is the effect.

The goal is crystal-clear: with the support of Avalanche Problems and Danger Patterns, perilous situations have to be quickly recognized, one's conduct adapted, and avalanche accidents avoided.

2.1 Avalanche Problem: Fresh-fallen Snow

Conduct: wait until the fresh-fallen snow has stabilized and/or behave defensively in outlying terrain.

Fresh-fallen snow does not automatically mean that avalanche danger increases. That depends - as so often is the case in avalanche science - on a number of different factors. What is always decisive is that the problem is directly related to the fresh-fallen snow; and that a critical mass is needed, as of which point a real problem arises.

Experience has shown that snowfall frequently occurs amidst wind influence. That is when we speak of a combined Snowfall-and-Snowdrift Problem.

On the other hand, if there is snowfall without wind influence, we are faced either with loose avalanches from rocky terrain or with slab avalanches, if the new-fallen snow bonds to the snowpack surface, for example due to warmth. In the case of heavy snowfall, on the other hand, the weight of the snow can be so great that weak layers near the ground fracture and as a result, large-scale avalanches can release. The "advantage" of the Fresh-fallen Snow Problem is that in general it is easy to recognize.

Fig. 1: Fresh-fallen snow (Possible Danger Patterns: dp.1 / dp.4 / dp.5 / dp.8 / dp.9)

2.2 Avalanche Problem: Snowdrift

Conduct: Heed signs of wind and circumvent snowdrift accumulations.

Wind and the snow which is transported by wind play major parts in the Snowdrift Problem. Snow can be transported during the snowfall (combined Snowfall-and-Snowdrift problem) or also when it is no longer snowing.

What matters most for this problem are the weak layers embedded inside the snowpack, on top of which the snowdrifts get deposited. It makes a big difference from what kind of snow crystals those weak layers are composed, since that is the direct cause of their lifespan. The longest snow-crystal lifespans are of depth hoar, faceted snow crystals and surface hoar. Nevertheless, it has often been observed in the Snowdrift Problem that a weak layer tends to expand inside the mass of fresh-fallen snow. This occurs, for example, when during a period of low temperatures powder snow gets covered by snowdrifts. In such a case, slab avalanches can easily trigger at the borderline between the powder snow, which serves as a weak layer, and the snowdrift.

If you are able to interpret wind signs, it is relatively easy to circumvent fresh snowdrifts, unless the drifts have been covered over by new-fallen snow. But frequently after a period of snow transport, people simply don't have the patience to wait until the situation has improved or at least lost its threat.

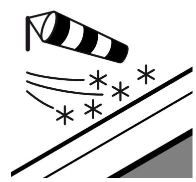

Fig. 2: Snowdrift (Possible Danger Patterns: dp.1 / dp.4 / dp.5 / dp.6 / dp.8)

2.3 Avalanche Problem: Old Snow

Conduct: select a conservative, prudent route and ski defensively. Special caution is required in areas where the snow is shallow, for example, in transitions from shallow to deep snow.

Old snow and the existence of weak layers inside the old snowpack are the pre-requisites of this avalanche problem. Old snow is defined as the snow which has been subjected to multiple influences over the course of several days, for example, precipitation, wind, melting. In regions (or in winters) where the snowpack is shallow, the Old Snow Problem occurs more frequently than in regions or winters where the snowpack is deep. It can occur in all aspects, but it occurs more frequently on shady slopes.

Slab avalanches occur most frequently as a result of additional loading where the snow is shallow or in transition zones from shallow to deep snow. This can occur even in flat terrain. Fracture propagation is possible over long distances, which in turn can cause an avalanche to grow to correspondingly large size. This problem is difficult to assess and usually is a long-lasting one, as is evident in the statistics. When experienced and educated people die in avalanches, it is usually as a result of the Old Snow Problem.

The only thing that helps in this situation is highly disciplined restraint and also - for experienced backcountry skiers - snow profile analysis of the old snowpack. By the way, a Fresh-fallen Snow Problem in a weak layer on the old snowpack surface tends to transform to an Old-snow Problem after several days without precipitation.

In springtime, as the snowpack becomes wetter and wetter, there is often a combined Old-snow Problem and Wet-snow Problem together.

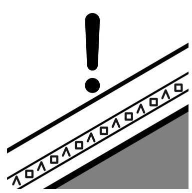

Fig. 3: Old snow (Possible Danger Patterns: dp.1 / dp.4 / dp.5 / dp.7 / dp.8)

2.4 Avalanche Problem: Wet Snow

Conduct: good timing and good route selection are decisive.

This avalanche problem arises due to ongoing wetness of the snowpack until it becomes thoroughly wet, which brings about a loss of firmness. This can occur either from rainfall or simply through the influence of warm air temperatures, intensive solar radiation, high humidity and warm winds, or a combination of these factors.

Especially critical is the first penetration of water into a weak snow layer (in a winter with little snow, the danger level increases quite rapidly); or massive water deposits atop a hardened snow crust; or when snowfall turns to rainfall.

Wet-snow avalanches, regardless whether they trigger as a slab avalanche, a loose-snow avalanche or a gliding avalanche, have enormous potential of danger and destruction. A Wet-Snow Problem is relatively obvious. Good route planning of your tour and good timing are important, not least because the danger level can rapidly increase as the snowpack becomes wetter.

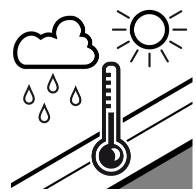

Fig. 4: Wet snow (Possible Danger Patterns: dp.3 / dp.10)

2.5 Avalanche Problem: Gliding Snow

Conduct: Do not stay near (or even go near) glide cracks.

This avalanche problem arises through the sliding away of the entire snowpack on steep, smooth slopes. Gliding avalanches frequently "announce" their imminent release by cracks in the snowpack surface. The actual moment when they will trigger is impossible to predict, but they occur most frequently in autumn following heavy snowfall or in springtime when the snowpack becomes thoroughly wet for the first time.

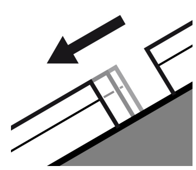

Fig. 5: Gliding snow (Possible Danger Patterns: dp.2)

3. A NEW BOOK

We have written up our experiences in a book which was first published in November 2010, entitled “Avalanche: Recognizing the 10 Decisive Danger Patterns”. In November 2015, the completely reworked fifth edition was published, and now includes the Five Avalanche Problems.

Our goal is clear: through employing this practical handbook we wish to supply an important impulse which permits people to quickly and easily recognize danger scenarios based on Avalanche Problems and Danger Patterns so that they can adapt their conduct to the situation. We are convinced that our work with these problems has enormous potential to assist experts and amateurs alike. For several winters now, the Avalanche Warning Service of Tirol publishes both the relevant problem which currently prevails and the danger pattern which lies beneath it in its daily bulletins (see illustration below). It is hoped that this will help everyone to readily interpret the “danger level” which of course remains an indispensable item of information; and will permit us in future to develop and apply the right strategy to confront each situation.

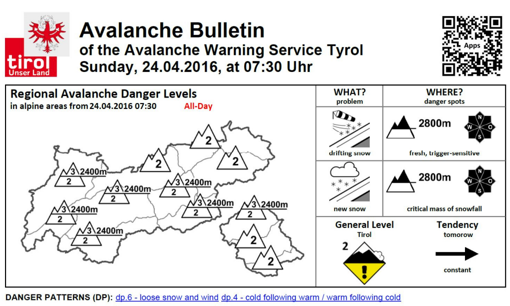

Fig. 6: Avalanche bulletin www.lawine.tirol with problems (What?) and danger patterns (Why?)

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