

Cartographic analysis of avalanche hazard maps

A comparison of relevant cartographic factors for the visualization of the avalanche bulletin



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Alpine touring received a real boost in the last few years

- A growing number of avalanche victims [cf. Würtl, 2005]:
 - Over 500 ski mountaineers on sunny days in some well-known areas
 - Winter season 2006/07: 22 people died, 52 people got injured
 - Winter season 2005/06: 48 people died, 72 people got injured
 - a total of 95 % of all victims trigger the avalanche themselves



Avalanche basics

- the dry slab avalanche is the „killer“
- a slab is a cohesive plate of snow that slides as a unit on the weak layer
- typically about 150 m long, about 50 cm deep, accelerates to around 130 km/h.
- the rapid addition of the weight of a person can easily initiate the fracture of the slope.
- meteorological and topographical factors are responsible for such terrible threats:
 - meteor. factors: wind, temperature, solar radiation
 - topogr. factors: morphology, aspect, height, slope

[Tremper, 2001]



Avalanche bulletin

- Headline
- Avalanche hazard map
- The Avalanche hazard level according to the European avalanche hazard scale
- The avalanche danger and avalanche prone locations
- The composition / condition of the snow blanket (setting, layering, wetting)
- The past and present weather situation and the snow blanket resulting from it
- The assumed further development of the situation (prognosis)

[cf. Land Tirol, 1988]

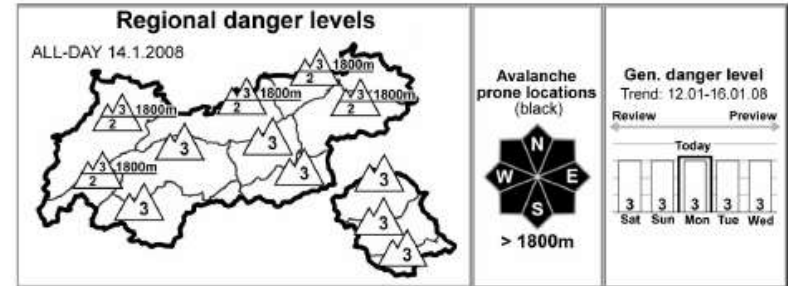


Lawine

Avalanche Bulletin

Monday, 14.01.2008, at 07:30 Uhr for Tyrol

Considerable avalanche danger widespread



Avalanche Danger:

In the backcountry skiing regions of Tyrol, generally unfavourable conditions prevail, with considerable avalanche danger.

Avalanche prone locations are found on steep slopes, areas adjacent to ridge lines and snowdrift-filled gullies and bowls in all aspects above approximately 1800 m. The snowpack is highly trigger-sensitive, a slab can be unleashed even by minimal additional loading, including the weight of one single backcountry skier or freerider.

The hazards of natural avalanches have diminished somewhat. Nonetheless, caution must be exercised, in particular on extremely sunny slopes.

Snow Layering:

In the past 24 hours a few centimeters of snow fell in East Tyrol only. All measurement stations show significant consolidation of the new snow. In areas adjacent to ridge lines and in those areas subject to foehn winds in particular, new snowdrift accumulations have formed.

The new snow and the snowdrift cover an old snowpack extremely prone to triggering, particularly in inneralpine regions: the base consists predominantly of a floating snow layer; yet also further up in the snowpack, loosely packed intermediate layers and surface crust are deposited which could form avalanche glide surfaces. The high trigger-sensitivity of the snowpack was corroborated yesterday by numerous natural avalanches as well as by avalanches triggered by backcountry skiers and freeriders. The snow layering along the northern flank of the Alps is somewhat more favourable.

Alpine Weather Forecast (ZAMG Weather Service Innsbruck):

A complex low front over Iceland and England will supply Tyrol with very cloudy, relatively mild Atlantic air. Intermittently foehn weather patterns are expected repeatedly in the course of the week. From the southwest, cloudbanks of a disturbance not affecting North Tyrol will move across the land today, although on the southern flank of the Alps light showers cannot be ruled out.

Tyrol's mountain summits are generally clearly visible, only the peaks from the Ötztal to the Ortler group are in clouds. The cirrostratus clouds moving in will dim views of the distance and make contours in the snow difficult to recognize. The freezing level is at 1800 m, the foehn winds will be evident primarily on the Main Alpine Ridge. Temperatures at 2000 m will be minus 2 degrees, at 3000 minus 7 degrees. High altitude winds will be moderate, on the Main Alpine Ridge strong southwesterly winds of 40 km/h will prevail.

Short-term development:

The avalanche danger is not expected to diminish soon.

Rudi Mair

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Relative frequency of the avalanche bulletin-check

Avalanche bulletin-Check	Percentage
Several times a week	43 %
Only while planning a tour	32 %
Every day in winter	22 %
Rare	2 %
Never	1 %

ITS COVER www.lawine.at 24.01.2008

Österreich Reiseführer | Hotels/Unterkünfte | Felschalen

Tirol
Aktuelle Infos
Landschaftsbild
Tafelberg
Massataktion
Alpenwetterbericht
Tourenliste
Schneestatus

Service
Buchungsdienste
Gefahrenstufen
weitere Karten
SMS und MMS
Toureninfo-App
Kartensysteme

Archiv
Landschaftsbilder
Gefahrenstufen
Schneestatus
Felssturzrisiko
Landschaftsbild

English Version
Avalanche Report
updated Report at
about 8:00 am

AKTUELLER LAWINENLAGEBERICHT
Angaben aktualisiert am 24.01.08, 07:20 Uhr

Besonders inneralpin und in Osttirol bleibt die Schneedecke in mittleren Höhenlagen störanfällig

Regionale Gefahrenstufenkarten (GSK)

GSK 24.1.2008 AM GSK 24.1.2008 PM

Vormittag Nachmittag

Gefahrenstufen vorwiegend (schwarz):

Allgemeine Gefahrenstufe:

- sehr groß
- groß
- erheblich
- mäßig
- gering

Bewertung der Lawinengefahr
Die Lawinengefahr ist leicht zurückgegangen, allerdings meist noch höhenabhängig. Unterhalb etwa 2000m bis 2300m herrscht häufig mäßige, darüber teilweise erhebliche Gefahr. Kritischer ist die Situation unverändert in den Regionen der Ötztal-, Stubai-, Zillertal-, Tuxer Alpen sowie in Zentralosttirol und dem Osttiroler Dolomiten einzuschätzen. Dort können besonders in einem Höhenbereich zwischen etwa 1800m und 2500m vermehrt in den Expositionen NW über N bis O Schneesbreitlawinen im Steilgelände aufgrund eines meist störanfälligen Schneedeckendefizits durch geringe Zusatzbelastung ausgelöst werden. Weitere Gefahrenstellen finden sich derzeit vor allem in karrennahen Gefällungen der E- und N über O bis SO sowie in steilen Rinne- und Mulden in Form von frisch gebildeten Treibschneeanstimmungen, die mitunter auch noch durch geringe Belastung gestört werden können. Günstiger ist es in tieferen Lagen sowie im verborgenen bzw. befahrenen Touren- oder Variantenbereich. Durch die warmen Temperaturen verbunden mit der eher höheren Luftfeuchtigkeit werden aus sehr steilen besonnten Hängen Nassschneerutsche zu beobachten sein.

Lawinenwarndienst Tirol
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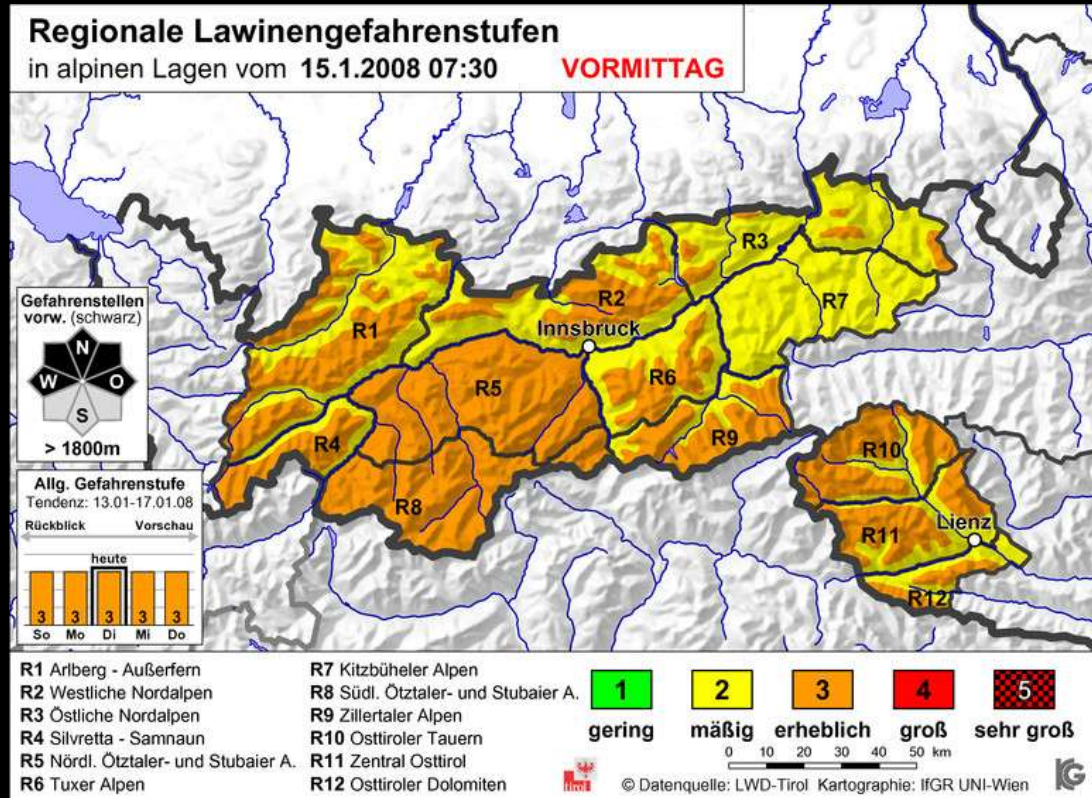


Avalanche hazard map

- incorporates mainly a topographic map with thematic avalanche features [Kriz, 2003].
- communicates the information quickly
- „translates“ the very difficult and specific written avalanche bulletin
- shows current avalanche risk levels

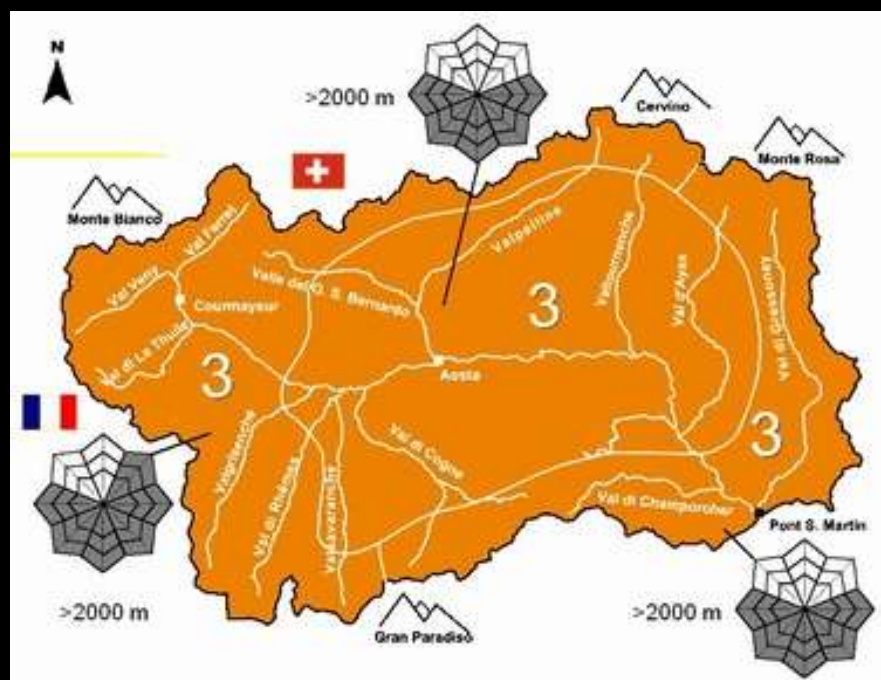


THIS IDEAL CASE IS NOT ALWAYS GIVEN!

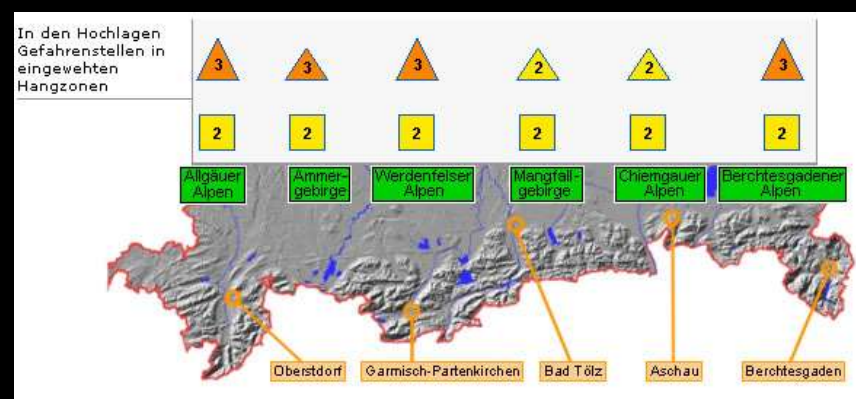


Questionnaire

- cartographic analysis of the avalanche hazard maps of 26 avalanche warning services in Europe
- range of cartographic products from high quality visualizations over simple bitmaps to hazard charts



Italy



Germany Bavaria

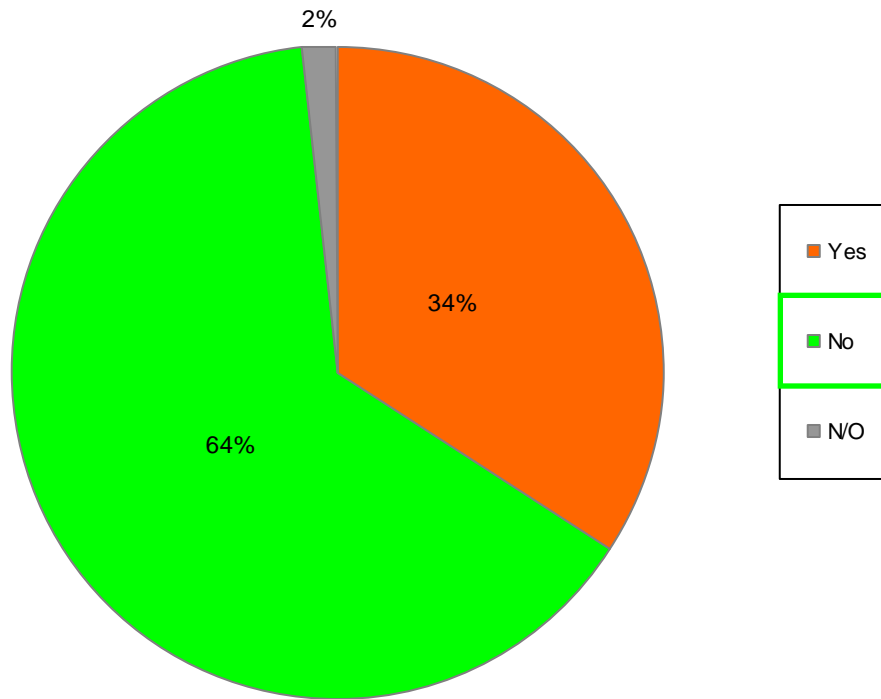
Lavinová situácia na horách dňa 24.01.2008 o 9.00 hod.

Poveternostné podmienky v odtrhových zónach lavín					
Pohorie:	Vysoké Tatry	Západné Tatry	Ľľízke Tatry	Veľká Fatra	Malá Fatra
Stupeň lavinového nebezpečenstva:	3 - zvýšené	3 - zvýšené	2 - mierne	1 - malé	2 - mierne
Tendencia lavinového nebezpečenstva:	→ zotrvalá	→ zotrvalá	→ zotrvalá	→ zotrvalá	→ zotrvalá

Slovakia

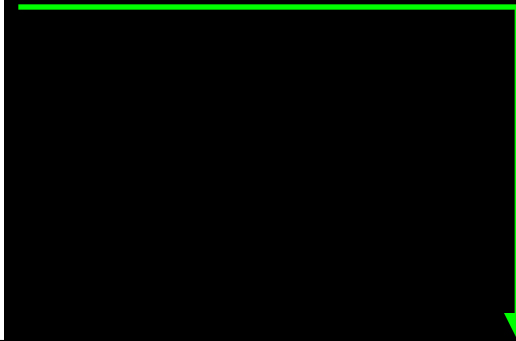
- a survey carried out on 167 protagonists was made:
 - maps with detailed hazard levels for small, well-defined areas are indispensable
 - maps with the hazard level dissolved over a large area is dispensable

Is the visualization of the written bulletin dispensable?



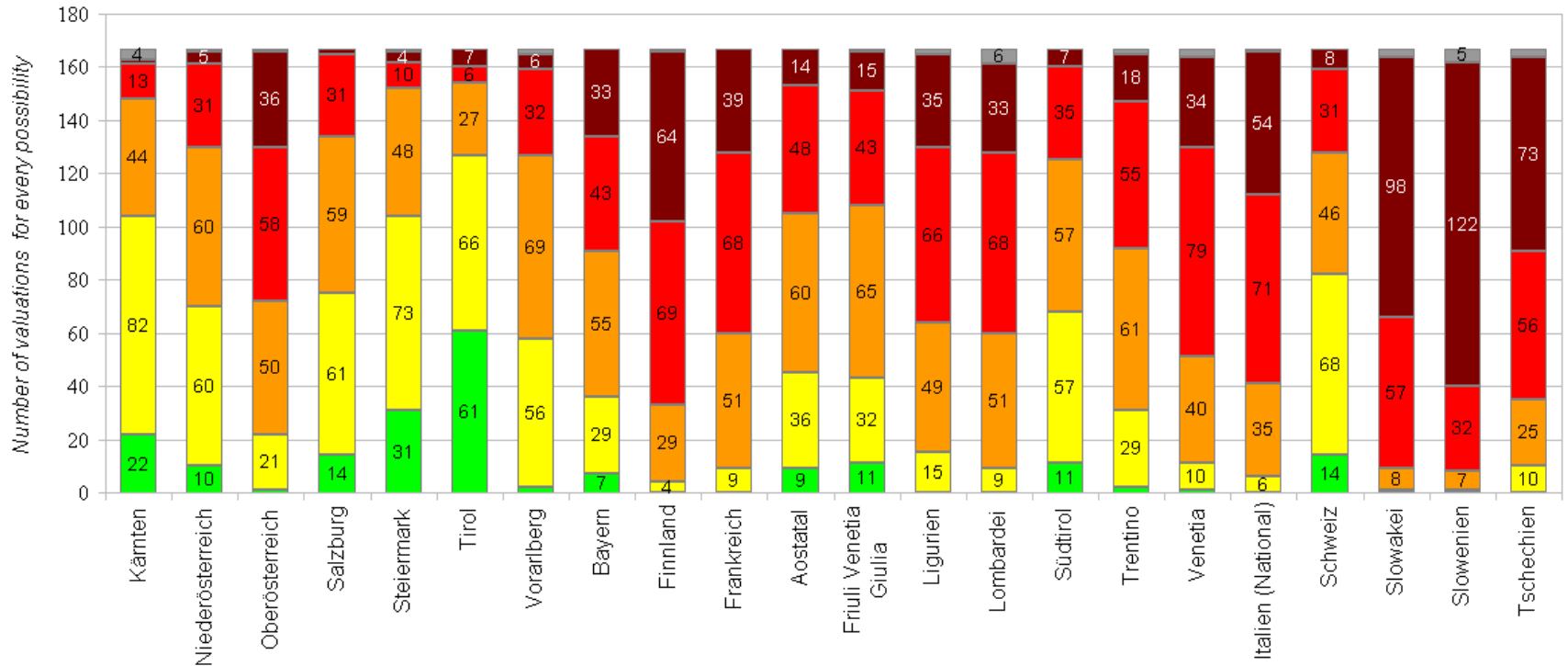
Is the Avalanche hazard map dispensable?

= 64 % say NO



- a consistent high-quality standard for avalanche hazard maps, following common cartographic rules should be achieved
- the avalanche hazard map should fulfill its role as a carrier of communication and information in the sense of the cartographic communication process.
- the avalanche hazard map offers a direct connection between the cartographic product and the user, as well as the possibility to respond.

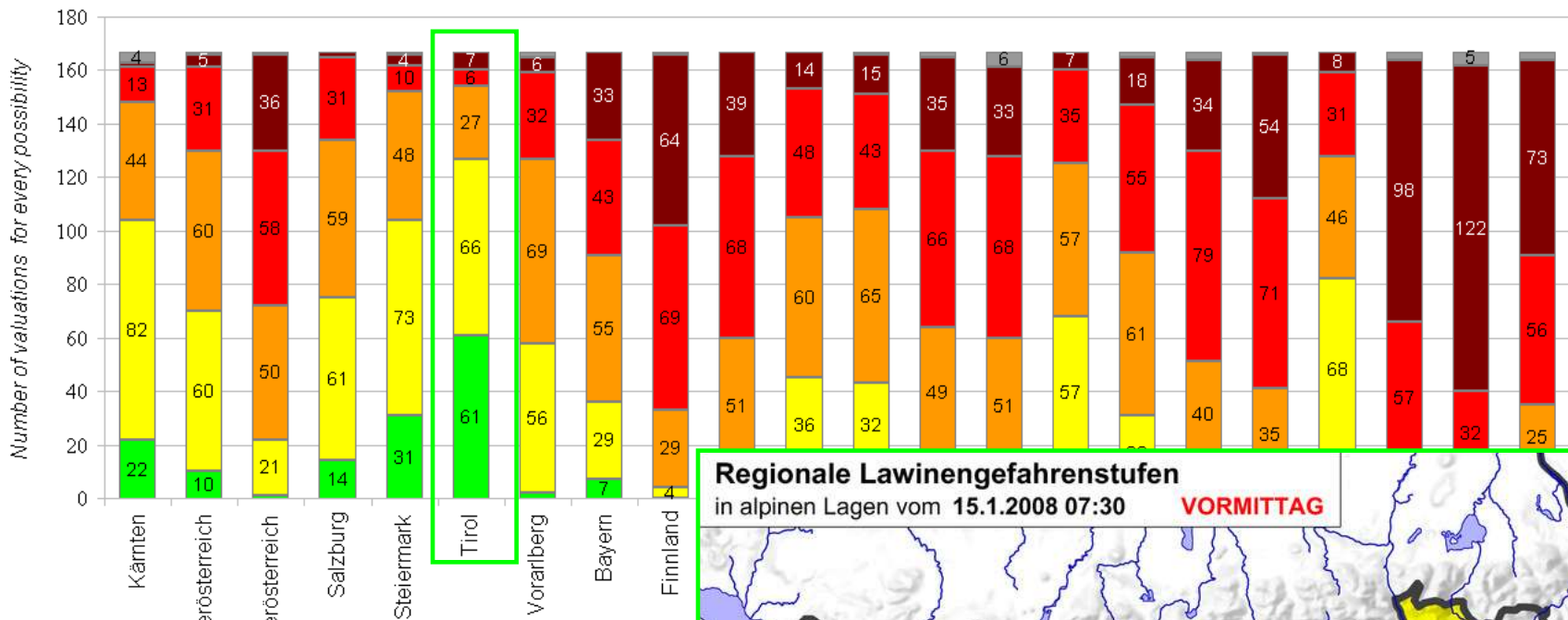
Valuation of the visualized avalanche hazard maps in Europe



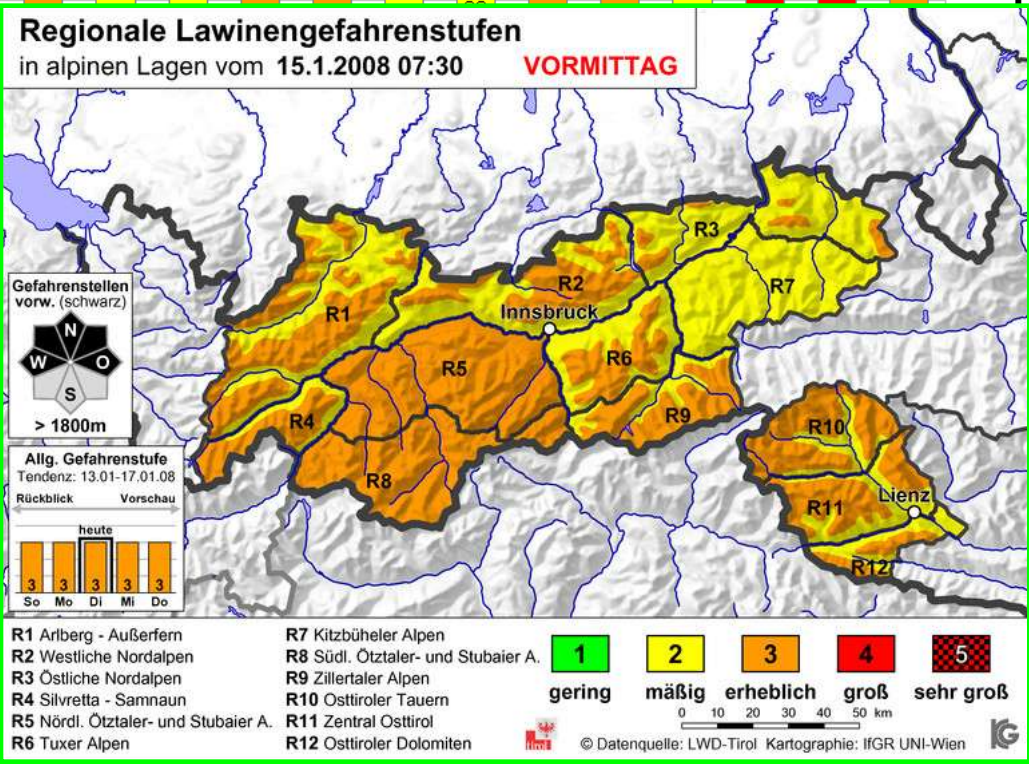
Avalanche warning services in Europe



Valuation of the visualized avalanche hazard maps in Europe

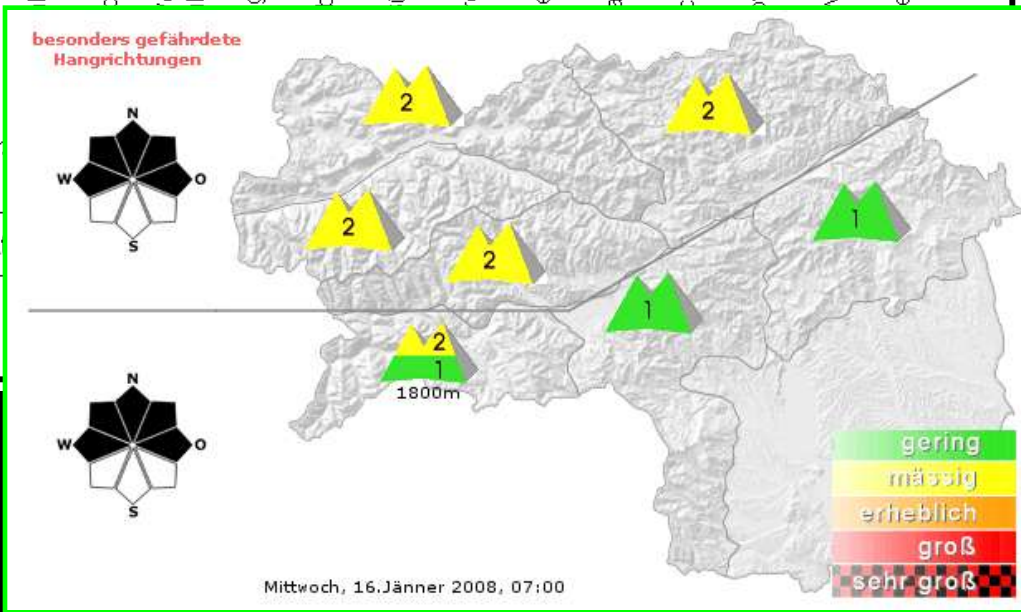
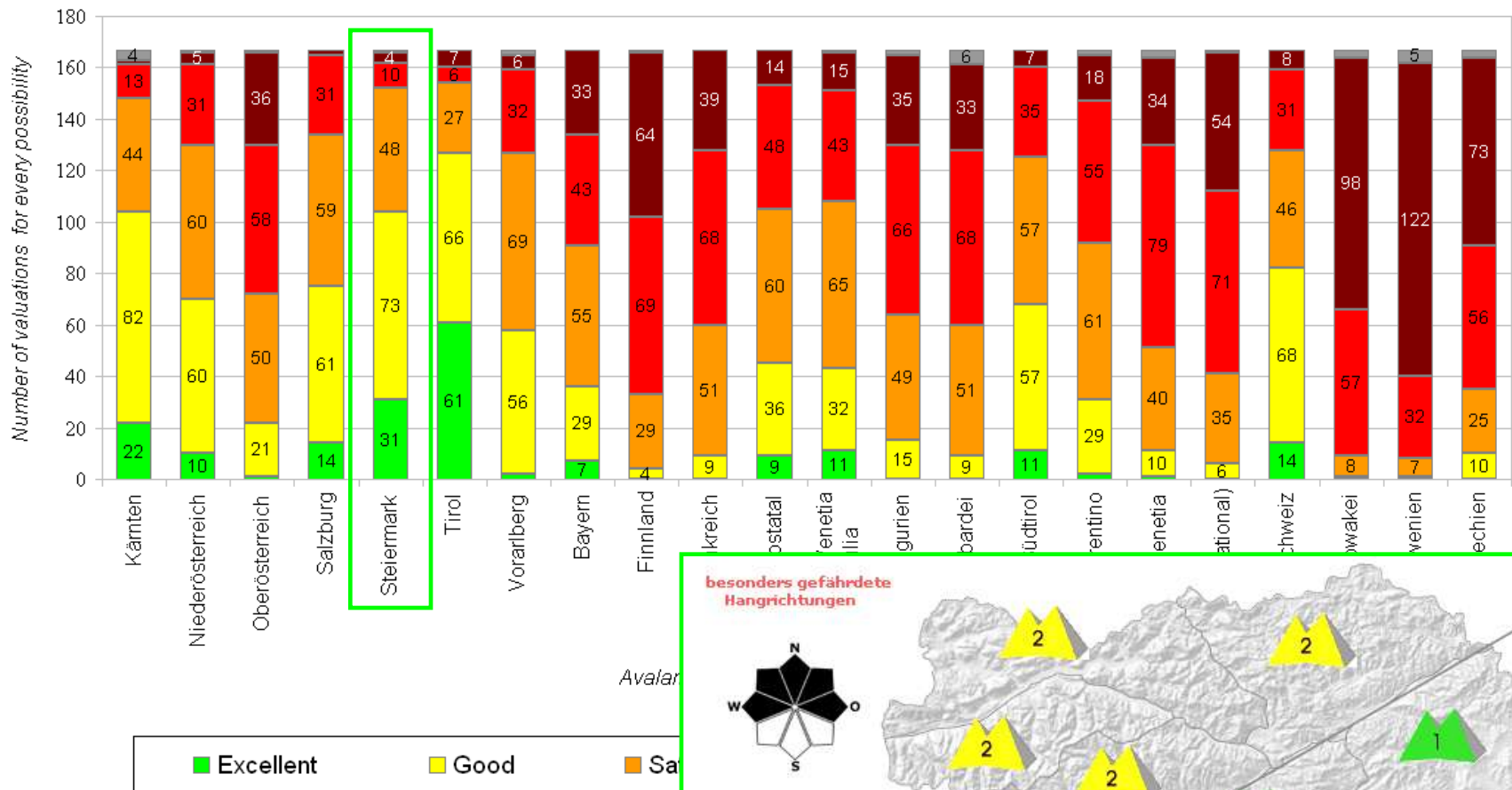


■ Excellent
 ■ Good
 ■ Satisfactory



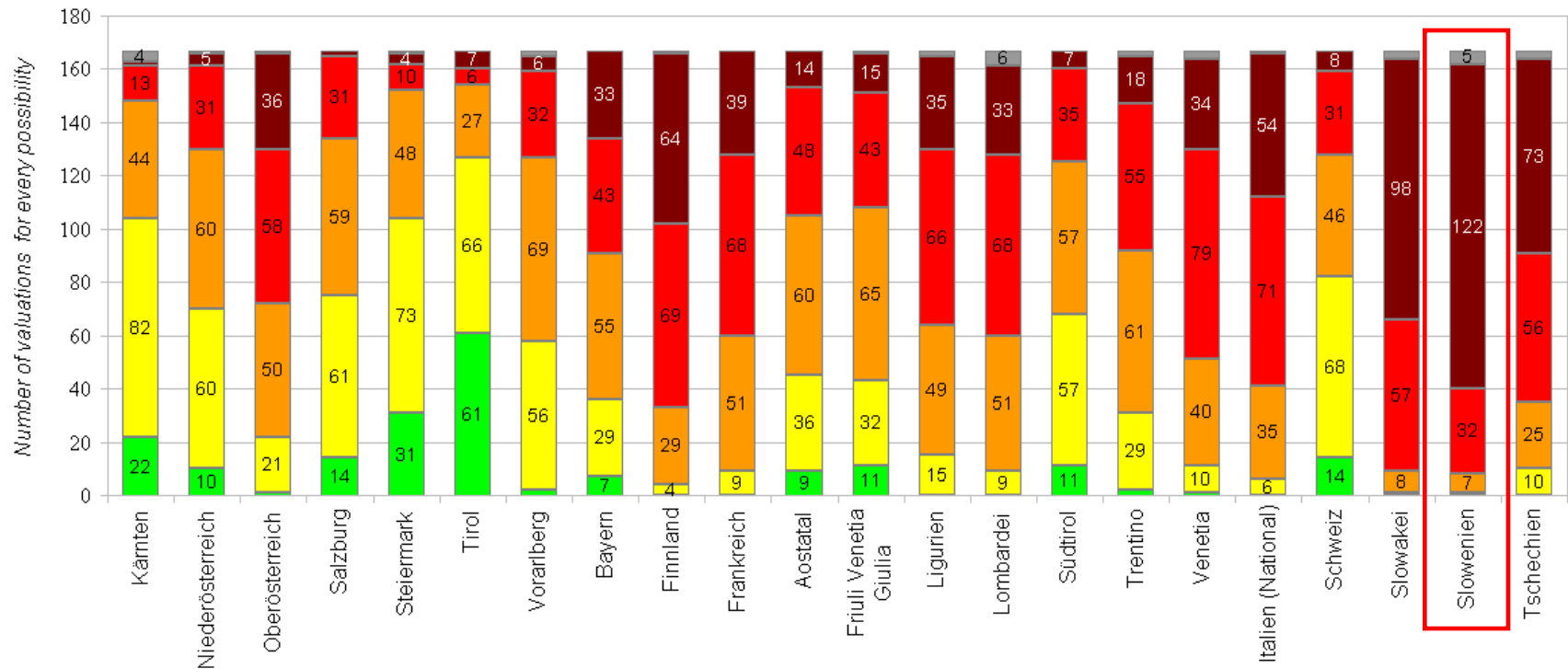
Tyrol = 61 from 167 rated „Excellent“

Valuation of the visualized avalanche hazard maps in Europe



Styria = 31 from 167 rated „Excellent“

Valuation of the visualized avalanche hazard maps in Europe



Avalanche warning services in Europe

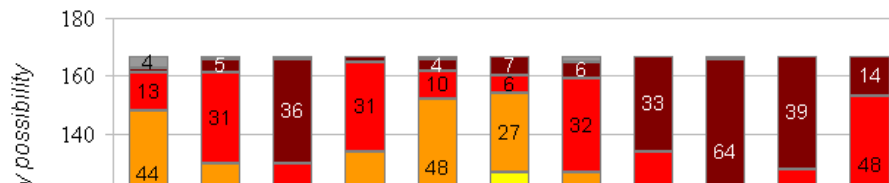
Snežne razmere

Sreda, 16. januarja 2008



Slovenia = 122 from 167 rated „Not Suitable“

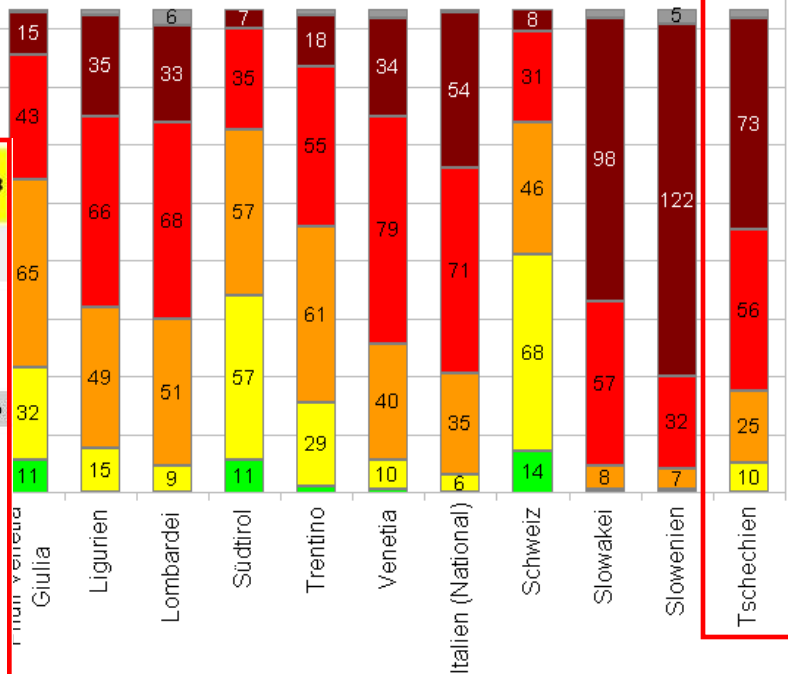
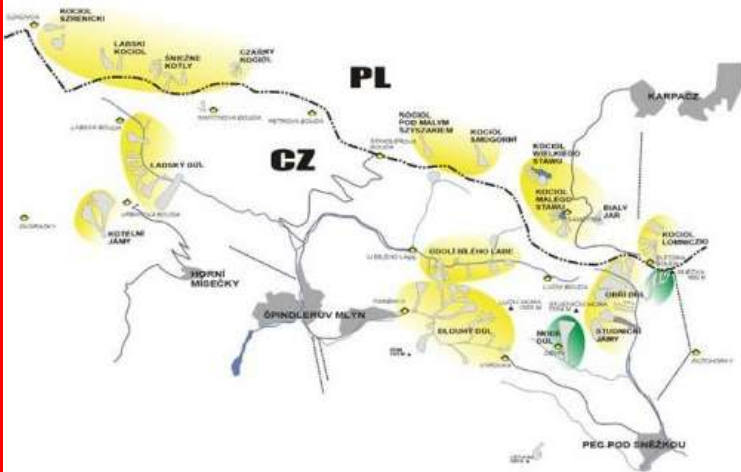
Valuation of the visualized avalanche hazard maps in Europe



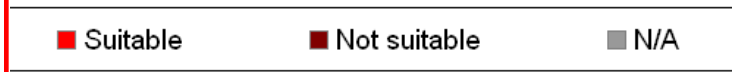
KRKONOŠE - LAVINOVÁ PŘEDOVĚŤ DATUM: 16. 01. 2008

STUPEŇ LAVINOVÉHO NEBEZPEČÍ	TENDENCE	NEBEZPEČNÁ EXPOZICE	SNĚHOVÝ PROFIL LUČNÍ BOUDA	SNĚHOVÝ PROFIL KOTEL
1. NÍZKÉ	↓ klesající	☀ všechny	📊 NESTABILNÍ	📊 STABILNÍ
2. MÍRNÉ				
3. ZNAČNÉ				
4. VYSOKÉ				
5. VELMI VYSOKÉ				

Info tel.: +420 499 433 230, +420 499 433 239 SOS tel.: +420 602 448 338, +420 499 433 230 nebo 155 (112 - v příp. PL signálu)



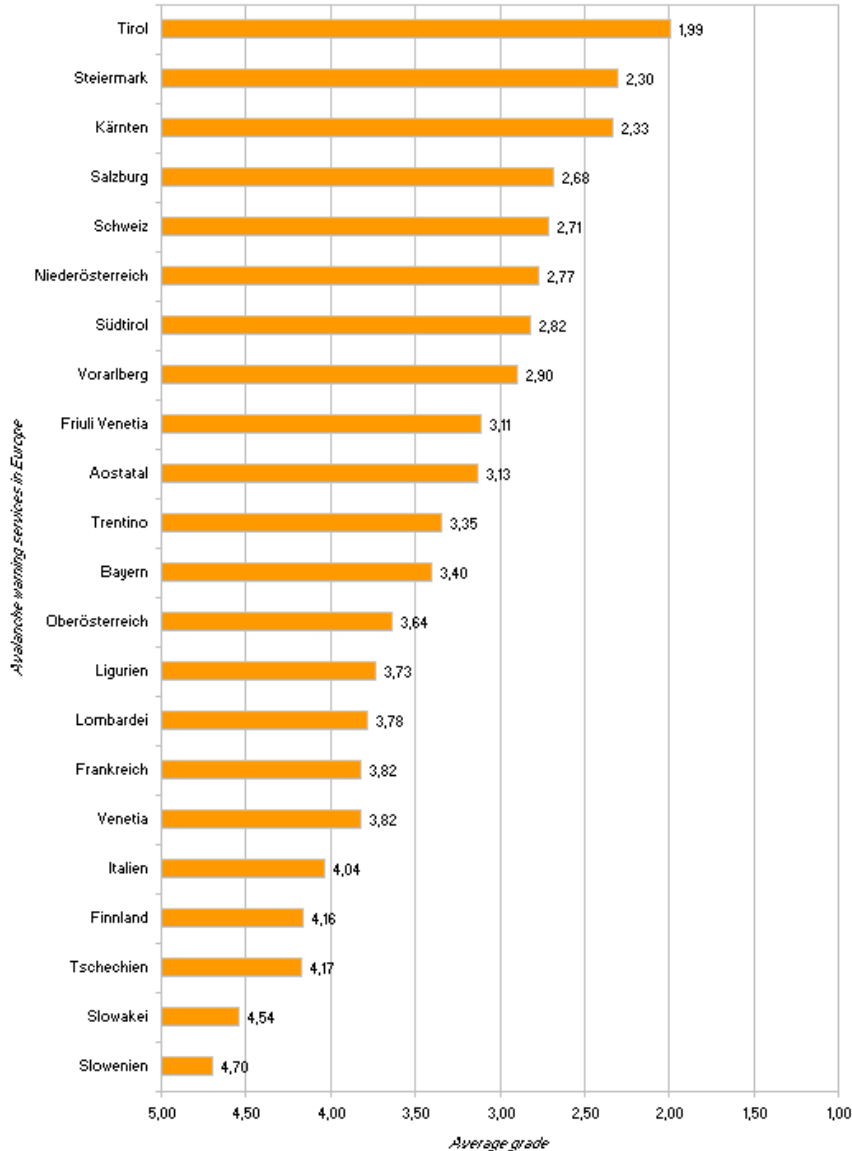
services in Europe



Czech Republic = 73 from 167 rated „Not Suitable“

Conclusion

Average grade for every visualization of the European avalanche warning services



Top score Tyrol with average grade of 1,99

followed by Styria (2,30), Carinthia (2,33) and Switzerland (2,71)

+ clear topographic representation
+ classification of various mountain regions
+ good and fast overview and orientation
+ Differentiation of the hazard level by region, height and daily temperature curve and aspect.

last place for Slovenia with average grade of 4,70

- insufficient information of the stacked bar graph without key

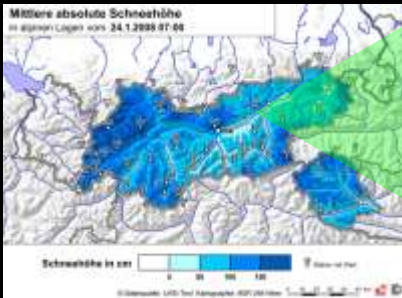
followed by Slovakia (4,54), Czech Republic (4,17)

- unclear, mistakable visualization (Czech R.)

Catalog of requirements

Because of extensive measuring data, geodata, cartographic knowledge and the inclusion of other sciences (web design, psychology of perception, ...) a clear cartographic visualization should be aspired:

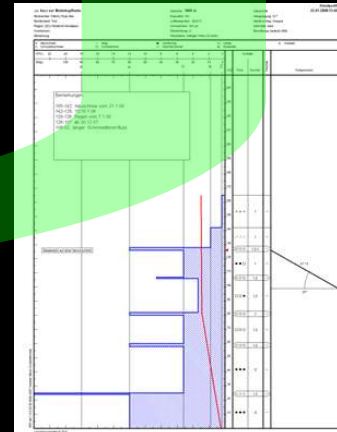
- Differentiation and cartographic visualization of the avalanche hazard level
- Topography
- Map elements and cartographic visualization
- Technical implementation and web design
- Color and cartography / psychology of perception



Database Table Information
Table Name: wetter
Maximum Timestamp in Table: 2008-01-24 07:00:00

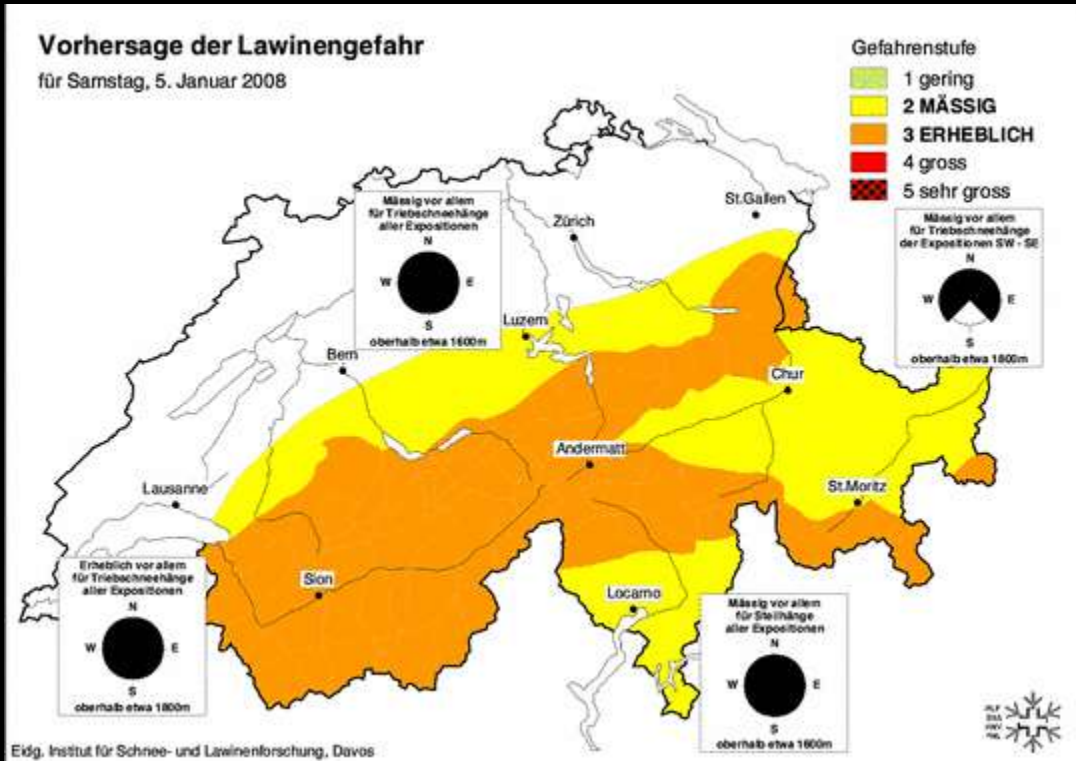
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2007	1	22	3	3	sdof_24		aktuell	prg
2007	1	23	4	4	sdof_48		aktuell	prg
2007	1	23	5	5	sdof_72		aktuell	prg

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156	4307170222	46.7500	10.3200	47.350	2008	01	24	07:00:00	4.4	3.2
157	4307009811	46.7500	10.3200	47.380	2008	01	24	07:00:00	6.7	80
158	4307041921	46.7500	10.3200	47.050	2008	01	24	07:00:00	3.8	
159	4307041912	46.7500	10.3200	47.040	2008	01	24	07:00:00	1.5	77
160	3000190132	46.7500	10.3200	46.660	2008	01	24	07:00:00	-4.7	2
161	3000190132	46.7500	10.3200	46.660	2008	01	24	07:00:00	-1	83
162	4307118621	46.7500	10.3200	46.740	2008	01	24	07:00:00	-3.1	0.3
163	4307113712	46.7500	10.3200	46.740	2008	01	24	07:00:00	1.1	83

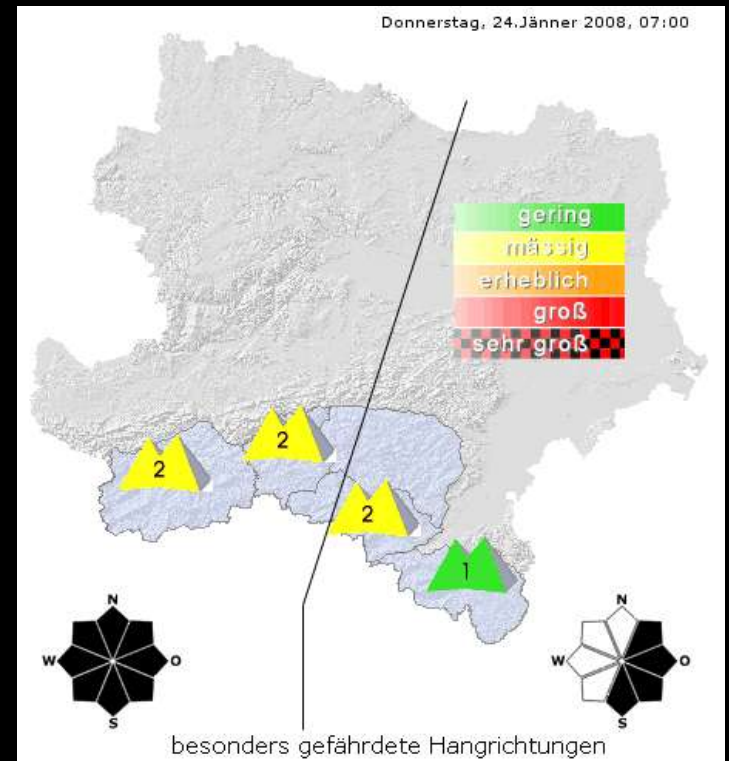


Differentiation and cartographic visualization of the avalanche hazard level

Differentiation by region



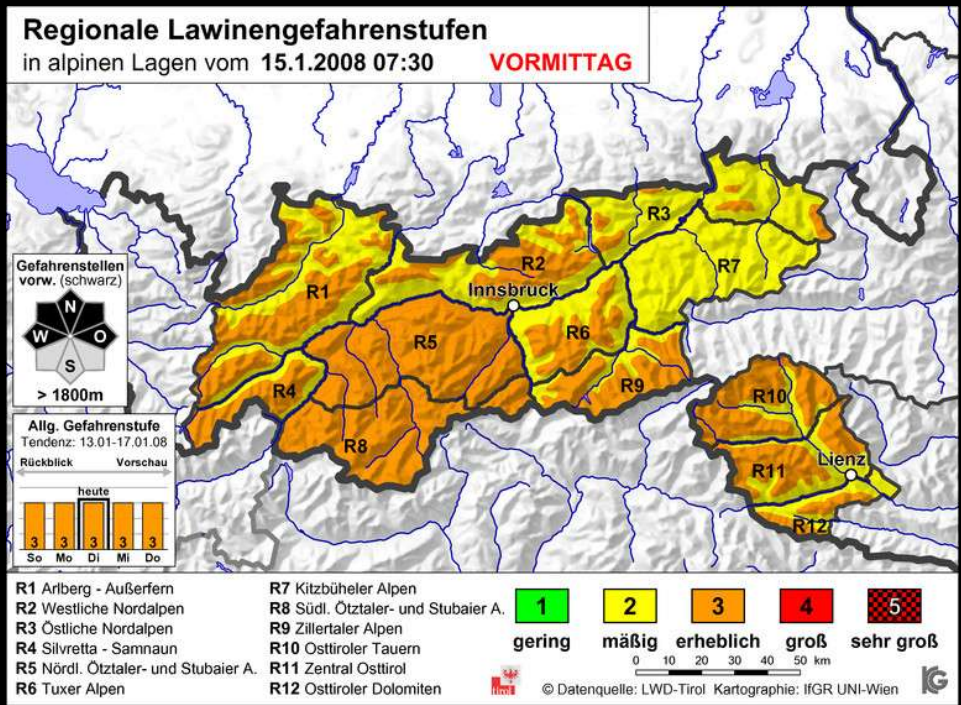
by colouring the different regions, separated by the region borders



by using a multilayer, colored signature with the hazard level as a number

Differentiation and cartographic visualization of the avalanche hazard level

Differentiation by height



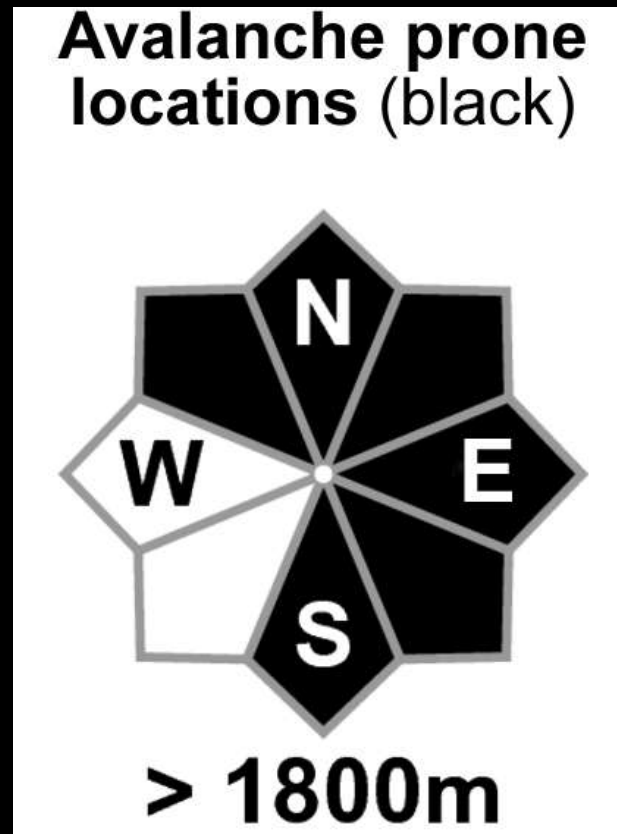
by coloring the different altitudes using a DTM



by using a multilayer, colored signature with the hazard levels as a number and the height, at which the hazard level changes

Differentiation and cartographic visualization of the avalanche hazard level

Differentiation by aspect



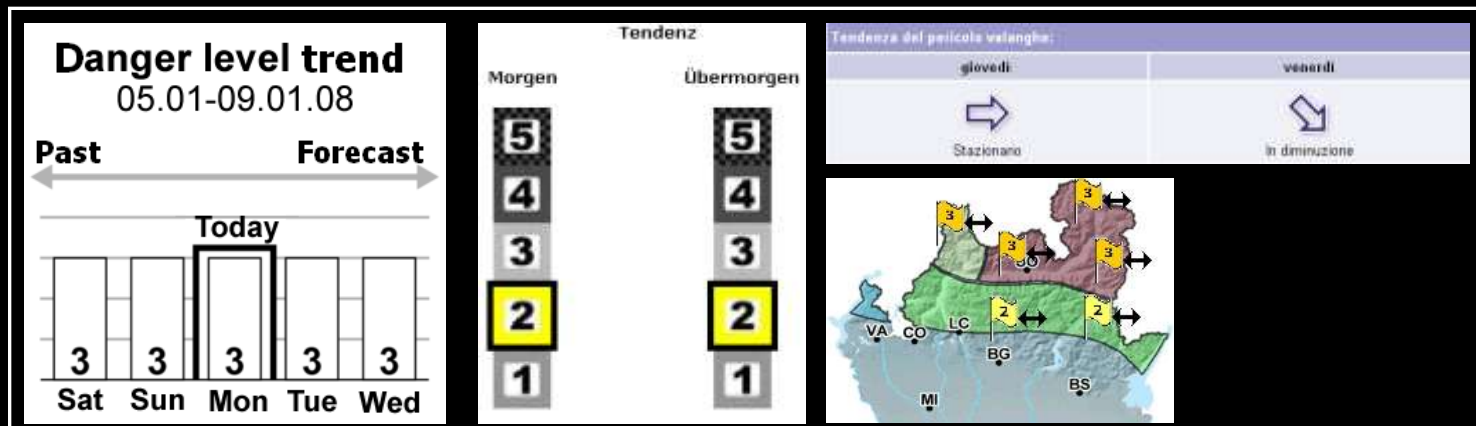
by using a wind rose displaying avalanche prone locations for the indicated altitudes

Map elements and cartographic visualization

- Cartographic design issues / visualization of the thematic elements are important to understand the topic, essential for spatial communication.

Map elements:

- Title, Frame, Key
- Highlighting important information
- Date and Time (up-to-date map)
- Hazard level trend (Arrows or a chart)



KEEP IT SMART AND SIMPLE !



- Analyzing the gateway between hazard map and user (heterogeneous usergroup)

„What interfered with the person’s judgment at the crucial moment“

- Try to raise the avalanche warning service’s awareness of the importance of a high-quality avalanche hazard map
- Try to give guidelines and examples of high quality cartographic visualization
- Try to install standards for map elements and topographic representation, as well as avalanche specific features for avalanche hazard maps.

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A comparison of relevant cartographic factors for the visualization of the avalanche bulletin



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