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]
<table>
<thead>
<tr>
<th>Avalanche bulletin-Check</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Several times a week</td>
<td>43 %</td>
</tr>
<tr>
<td>Only while planning a tour</td>
<td>32 %</td>
</tr>
<tr>
<td>Every day in winter</td>
<td>22 %</td>
</tr>
<tr>
<td>Rare</td>
<td>2 %</td>
</tr>
<tr>
<td>Never</td>
<td>1 %</td>
</tr>
</tbody>
</table>
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

- 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?

- 34% Yes
- 64% No
- 2% N/O

= 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
Tyrol = 61 from 167 rated „Excellent“
Styria = 31 from 167 rated „Excellent“
Slovenia = 122 from 167 rated „Not Suitable“
Czech Republic = 73 from 167 rated „Not Suitable“
Conclusion

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
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!**
Outlook

- 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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