Avalanche Warning Service without Frontiers in the Karavanks along the Slovenian-Austrian border

Arnold Studeregger[1], Arnulf Wurzer[1], Hannes Rieder[1], Andreas Riegler[1], Willi Ertl[2], Manca Volk Bahun[3], Jaka Ortarand Miha Pavsek[3]

1 Institute of Meteorology and Geodynamic, Graz, Austria
2 Government of Carinthia Austria, Klagenfurt, Austria
3 Anton Melik Geographical Institute ZRC SAZU

ABSTRACT: The avalanche warning service was established within the frames of Operational program SI–AT 2007–2013 project “Natural Hazards without Frontiers”. The first regular season was the winter 2012/2013. The avalanche and the slab avalanche situation in the transnational area along the 160 km border between the south of Austria and north of Slovenia show major differences of avalanche building weather situations. Because of the nearby sea in the southwest of Slovenia the prevailing weather situations for high precipitation are coming from southwest or southeast. Nevertheless sometimes a lot of fresh snow occurs at northerly weather situations, which is unusual for Slovenian Alps and is therefore poorly forecasted for this region. Austrian avalanche experts are facing the same problems at southerly weather situations. Hence an exchange of experience, weather data as well as model information improves the avalanche warning on both sides of the Austrian-Slovenian border.
Project partners are: Institute of Meteorology and Geodynamic, Graz, Austria, Government of Carinthia, Avalanche Service, Klagenfurt, Austria, Anton Melik Geographical Institute ZRC SAZU,Ljubljana, Slovenia and Geodetic Institute of Slovenia Ljubljana, Slovenia

KEYWORDS: Avalanche, Avalanche Bulletin, Avalanche Warning Service, Alps

1 INTRODUCTION

The cross-border Karawanks mountain range between Slovenia and Austria united avalanche services from both sides of these part of the South-eastern Alps (Project partner form the Project Natural Hazards without Frontiers/NH-WF, which is founded from SI-AT EU) offers end-users different possibilities to inform them about avalanches danger. For example: A back-country traveller can read in the avalanche report that in spring time the avalanche hazard is generally lowest during the night and early morning hours when surface snow refreezes due to heat loss to the surrounding atmosphere. The avalanche report is made during the winter time. The fact is that Slovenia does not have an avalanche warning service, organized and worked on the same way as this is the case in the other alpine countries. The Avalanche Bulletin for the Karawanks is one of the important steps towards the modern avalanche warning service. Products of the avalanche service for the end-user are following:

- Snow profiles
- Meteorological data
- Avalanche Report
- Homepage www.natural-hazards.eu

Corresponding author address: Miha Pavsek, Anton Melik Geographical Institute ZRC SAZU,Ljubljana, Slovenia;
email: miha.pavsek@zrc-sazu.si

2 INITIAL SITUATION

The assessment of avalanche danger is very difficult during heavy snow fall because of the restricted sight conditions. From this standpoint we have to ask:

How much snow actually is in the crack area of the avalanche slope?
Which is more appropriate route regarding the accurate danger level?
Is a back country ski tour still safe?

The following question is very important for the product development of the avalanche service: Who is the end-user? The end-users are known by the avalanche service. These are professional people who have a close relationship to snow, but also some locals and tourism businesses which have no close relationship to snow. Taking this into account there are different applications provided for different kinds of end-users.

The avalanche report is composed for all who either are working in alpine regions, living in Alps and for the people who are visiting them regularly or occasionally in their leisure time/free-time activities and are thus exposed to avalanche danger.

Subgroups of people:

- Members of the avalanche commission
- Back country skiers
- Skiers, snowboarders and snowmobilers.
- Operators of mountain railways/ski-lifts
- Alpine police
- Rescue services members
- Members of winter road-service
- Local inhabitants of alpine regions

3 MATIRAL AND METHODS

Besides the existing weather observation net of ARSO, ZAMG and avalanche service Carinthia, we take into account the data of three new meteorological stations, which started with operation on this area within the frame of NH-WF project. One output auf the project is an avalanche report for the Karawanks. The Avalanche Bulletin for the Central Karawanks was developed for better presentation and understanding of avalanche conditions and avalanche danger levels. We used a standardized and unified European Avalanche Danger Scale in some other information, which are component part of avalanche bulletins in the other alpine countries with well-developed and long-continued avalanche service. Slovenian partners tried to follow the daily issuing of the avalanche bulletin by their Austrian colleagues (number of avalanche service Carinthia and Styria in season 2012/13), but managed to publish it every day, the snow and avalanche conditions change significantly - together 67 avalanche reports during the whole snow season. Also the snow profile form was adopted and applied for those purposes.

The output was a result of different Information sources, avalanche building factors as well as avalanche danger level. Sources of information:

- Field observations (Fig. 1)
- Snow profiles
- Automatic weather stations (Fig. 2)
- Weather forecast
- Data about previous snow cover metamorphosis
- Current conditions

Fig. 1 field observation, March 2013

Fig. 2 new meteorological station Hochstuhl

Avalanche formation factors:

- Weather (precipitation, wind, air temperature, solar radiation, snow drift,…)
- Snowpack (per layer - stratification, weak layers, stability/strength, temperature, water content, moisture…)
- terrain characteristics (altitude, aspect, inclination, vegetation/land use, relief forms, …)
- Expert assessment – Data analysis, factor combination, empiric values

Avalanche danger:

- Snowpack stability
- distribution of avalanche prone slopes/locations, quantification/qualification/typification of avalanches;

AVALANCHE BULLETIN:
Danger levels, especially by avalanches endangered areas/slopes; description;

All together - meteorological measurements, field work (tree meteorological weather stations were built see Fig xy) with snow-sampling and avalanche danger level testing and the use information sources across the border enable us to reach the final output – the avalanche report. At the same time the data base for past avalanche events and hazards were retorted.

Issue the avalanche report

The daily avalanche report comprises a weather forecast for the current day and information about the snow cover. There you can read about dangerous exposition and the tendency of the future development of snow and avalanche conditions. As a result of different weather conditions is divided into the Karawanks:

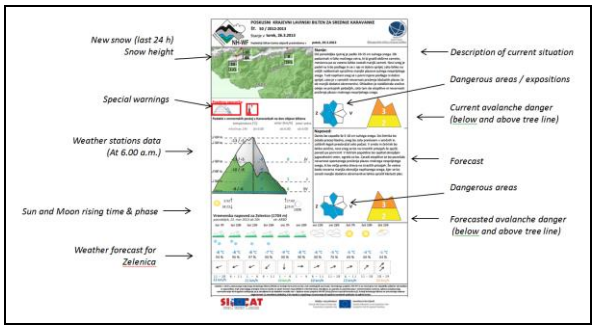

Fig: 3 Avalache bulletin for Central Karawanks, the input table was made on the platform of MS Access.

A very important basis for the writing the avalanche report are the snow explorations of the members of the GIAM and avalanche service Carinthia. They are going into Alpine regions to do snow cover analysis. Also the local weather and avalanche observers are being engaged with snow cover analysis and give their information to the avalanche service.

For the assessment of the short-time and long-term weather situation the avalanche service has different possibilities to inform the end-user about temperature, wind and snow. We have more than ten different weather models in different regional and seasonal forecast. The expected precipitation can also be interpreted by looking at satellite pictures.

Used weather models

ALADIN-AUSTRIA

The limited area numerical weather prediction model ALADIN (Aire Limitée Adaptation dynamique Développement InterNational) developed by 13 European national weather services within an international project has been in use operationally at ZAMG since September 1998. A new operational NWP-LAM system, ALADIN-AUSTRIA, was designed in 2003/2004. In this model not only the horizontal resolution was increased but also the number of levels from 37 to 45. In May 2004 ALADIN-AUSTRIA was put into operation at ZAMG.

The specifications of the operational LAM system are:

· 289x259 grid points
· Time step: 415 s
· Horizontal resolution: 9.6k m
· 45 vertical levels
· Coupling model: ARPEGE, coupling frequency: 3 h

ALADIN-AUSTRIA is also one member of PEPS (Poor Man Ensemble Prediction System) which tries to make predictability forecasts based on several different LAMs.

INCA (Integrated Nowcasting through Comprehensive Analysis)

The high-resolution analysis and nowcasting system (INCA) is being developed at the Austrian national weather service (ZAMG). It provides three-dimensional fields of temperature, humidity and wind on an hourly basis, and two dimensional fields of precipitation rate (15 minutes) and cloud cover. The system operates on a horizontal resolution of 1km and a vertical resolution of 200m (601x351 grid points). It combines station data, remote sensing data (radar, satellite), forecast fields of a numerical weather prediction (NWP) model, and high resolution topographic data in order to generate analysis fields. In case of wind analyse and forecast the INCA system first makes a dynamical downscaling of the ALADIN-AUSTRIA (9.6 km to 2.3 km horizontal resolution). After that, wind observations at stations and ALADIN-AUSTRIA model become the INCA fields (kinematic downscaling, relaxation method). (cp. Haden 2006)

The dimension of avalanche danger is established of many parameters. Examples of these parameters are the relationship between atmospheric conditions and snow cover and snow composition and avalanche activity. The avalanche danger is determined by snow cover stability, and also of the correlation between tension and tightness in the ever changing snow cover. The influences of temperature, precipitation, and wind on the snow cover are the most important factors for the assessment of avalanche danger. The development in Alpine areas (exposition, elevation, and landform) is derived from these parameters.

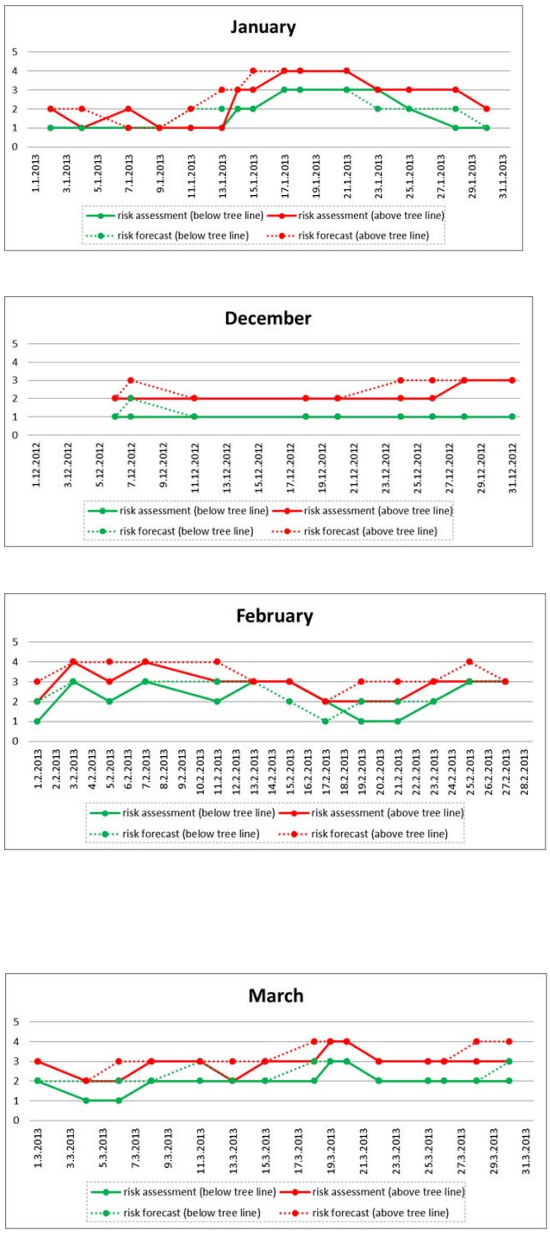

Fig 5: Avalanche Report for the Karawanks: for Central Karawanks: Avalanche danger level in the snow seson 2012/13 below/abowe the tree line.

5 RESULTS

The avalanche bulletin is identically constructed in
:

- Banner headline
- Avalanche danger
- Composition of snow cover
- Weather
- Trend

Map with the danger scale in different regions

The general map shows the avalanche danger level in the area (Karawanks) according to the unified European Avalanche Danger Scale (http://www.avalanches.org/).

Particularly endangered hillside directions

On the basis of two circle diagrams for the North part and for the South part of Karawanks particularly endangered hillside directions are referred to.

Headline

The headline comprises the most important avalanche-relevant statements in short form.

Danger scale for backcountry skiers

For the end-user the avalanche danger is noted as a number, this is given separately for each mountain area.

Full risk assessment

This section is intended for end-users who exercise in alpine areas. There you can find information about the possible triggering of avalanches based on the weather situation and on the snow cover composition. According to the European Avalanche Danger Scale the avalanche danger is low (1), moderate (2), considerable (3), high (4) and very high (5).

Composition of the snow cover/layer

In this part there is information about the current conditions of the snow cover/layer. Furthermore one can find indications of expected precipitation and the wind and temperature situation. When required there is information about fresh snow or recently sighted avalanches.

Weather

In this section there is a short description of the large-scale weather situation. Furthermore, the peculiarity of avalanche relevant climate factors is described. There are details about wind (wind speed, direction), precipitation (intensity, snow fall line,..) and temperature (zero degree line, temperature in 1500 m and in 2000 m). A short forecast for the next day is also part of this section.

Trend

In this section the end-user finds longer-term forecast about the weather and the changes of avalanche danger.

One of side effects or improvements of making the avalanche report was also a special avalanche traffic light (Fig. 6) near the Loibl parking plateau on the Slovenian side of the border, made by the members of the local Rescue Service Association and with the financial help of the commune Trzic.

Fig.6 a special avalanche traffic light near the Loibl parking plateau on the Slovenian side

6 REFERENCES

La Chapelle, 1980, The fundamental process in conventional avalache forecasting. Jornal of Glaciology, Vol. 26 (94), 75 – 84

Mc Clung, D.M., Tweedy J., (1993), Characteristics of avalanching: Kootenay Pass, British Columbia. Jornal of Glaciology, Vol. 39 (132), 316 – 322 S.

Simon Schneiderbauer, Walter Hinterberger, Peter Fischer, Arnold Studeregger, and Hannes Rieder. Improving, Avalanche Forecasts by Extracting Boundary Conditions from Measured Wind Data for Snow Drift Simulation in Alpine Areas. In Proceedings Managing Alpine Future, October 2007.

Schweizer J., Föhn P., 1996, Avalanche forecasting – an expert system approach. Journal of Glaciology, Vol. 42 (141), 318 – 332 S.

Studeregger A., Rieder H., Ertl W., 2012, Interpretation von meteorologischen Messstationen als Entscheidungsgrundlage für die Lawinenwarnung, Proceedings Interprävent Grenoble, S. 351 – 360, Grenoble 2012.

Schneiderbeuer S., Fischer P., Wurzer A., und Studeregger A., 2012, Potentials and challenges of snow drift simulation for avalanche warning, Proceedings Interprävent Grenoble, S. 119 – 130, Grenoble 2012.

Munter W., 2003, 3*3 Lawinen Risikomanagement im Wintersport. Agentur Pohl und Schellhammer, Garmisch Partenkirchen, 223

Haydn, Vortag 2006 Wien, Inca

Internet:
www.natural-hazards.eu