Web-Based Tool to Support Local Avalanche Services With Hazard Evaluation and Documentation

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ABSTRACT: Local avalanche services have to gain a quick overview of avalanche danger and snow condition. For this purpose, they have access to data retrieved by automatic stations and local observers employed by WSL Institute for Snow and Avalanche Research SLF. Own observations in combination with these data allow an estimation of the further development of the situation. The Swiss Syndicate of Avalanche Warning Systems (SILS) and SLF have developed a guideline describing the organization of an avalanche service and hazard evaluation. Additionally, a web application has been developed which supports this process and allows the documentation of decisions taken, e.g. road closure or the artificial avalanche release, together with the data retrieved and the hazard estimation made. The main goal of the application is to make the hazard evaluation as efficient and structured as possible. Second goal is to document the decisions taken. This application is intended as a support tool for local avalanche services. It can be customized and may be used additionally to own forms. It has been tested during winter 2007/08 and has gone operational in winter 2008/09. We inform about user feedback and give an outline of further development.

KEYWORDS: local avalanche service, avalanche protection, avalanche danger evaluation, hazard estimation, documentation.

1 INTRODUCTION

A guideline developed by the Swiss Syndicate of Avalanche Warning Systems (SILS) and WSL Institute for Snow and Avalanche Research SLF describes the procedure of hazard evaluation by local avalanche services (Stoffel and Schweizer, 2007).

Following this guideline, hazard evaluation happens in three steps (Stoffel and Schweizer, 2008):

1. Data analysis and estimation of avalanche danger
2. Hazard estimation
3. Decision about measures

For documentation purposes, step 2 and 3 may be combined (Stoffel and Schweizer, 2007). A web application has been developed to support this process and to document the hazard estimation process. It has been tested during winter 2007/08 and gone operational in winter 2008/09.

2 IFKIS-EVAL

The web-based tool is called IFKIS-EVAL since it is based on the Inter-Cantonal Early Warning and Information System (IFKIS). It consists of a web form containing the questions to be addressed. All potential users of IFKIS-EVAL have access to IFKIS.

IFKIS-EVAL has been presented to local avalanche services. Interested members could register and have access to IFKIS-EVAL since at least middle of winter 2008/09.

2.1 Modular structure

IFKIS-EVAL mainly follows the guideline and comprises three modules of one web page each:

a. Data retrieval
b. Estimation of avalanche danger
c. Decision about measures (hazard estimation)

Step 1 proposed in the guideline is realized in a and b whereas c combines step 2 and 3 (hazard estimation and decision about measures).

At the end of each module, the procedure can be stopped and a file is created which contains the station data and form input. The parts of the form which are not filled in are printed as a template which can be completed manually. So, it is possible to print out the empty form together with the station data and fill it out manually.

2.2 Customization

IFKIS-EVAL may be customized. For each local avalanche service, individual lists of relevant automatic stations and local SLF observers

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are defined. Local observation fields are located at a considerably lower altitude.

Facilities which are to be protected and avalanche tracks which are subject to artificial release are listed individually for each local avalanche service.

2.3 Technical requirements

No software has to be installed additionally to a web browser. The application is being tested on various platforms with different browsers.

3 HAZARD EVALUATION WITH IFKIS-EVAL

Evaluating the local avalanche danger consists in the following steps.

3.1 Data analysis

On the first page, actual data retrieved from automatic stations and local SLF observers is displayed together with data from the last days.

For each snow station, the following data is listed in a tabular form:

- Amount of new snow fallen during the last 12, 24 and 72 hours (model data)
- Snow depth: actual and 72 hours ago
- Snow drift
- Air temperature: actual and 24 hours ago
- Snow surface temperature: actual and 24 hours ago

A wind station is assigned to each snow station. The following wind station data is listed:

- Two main wind directions
- Mean wind speed
- Maximal gust of wind

Data of automatic stations is supplemented with measures taken by local SLF observers. This data is shown:

- Snow water equivalent (according to the amount of new snow fallen during the last 24 hours)
- Depth of new snow fallen during the last 24 and 72 hours
- Snow depth: actual and 72 hours ago
- Penetration depth
- Snow drift

The user examines the data carefully. He has to decide whether a detailed evaluation of the danger situation is necessary.

According to circumstances, he can stop here and print out the form for documentation purposes.

Figure 1 shows the station data list.

3.2 Evaluation of the danger situation

Observations of weather and snow conditions are collected by the user and supplemented with information from other local avalanche services. He makes a forecast and danger estimation and enters them into the application form.

Information about the following is needed:

- Snow surface quality
- Actual weather, snow fall period, danger signs, air temperature
- Natural avalanches observed
- Artificially released avalanches
- NXD results, if available
- Information of neighbouring avalanche services
- Weather forecast

Then, the avalanche danger has to be estimated as follows:

- Progress of avalanche danger in the past
- Future progress of avalanche danger
- Estimated danger level
- Areas with estimated danger level different from the one predicted

At this point, if no hazard evaluation is needed the form may be printed out for documentation purposes.

Figure 2 shows part of the evaluation form.

3.3 Decision about safety measures

When facilities are in danger or avalanche tracks have to be released artificially, the proposed and/or taken safety measures may be documented on the last page of the form.

The user gets a tabular list with the facilities he has to protect. Among others, these may contain roads, railway lines, buildings, ski runs and hiking trails. For these facilities, a proposed or taken safety measure may be indicated and motivated.

The discontinuation of safety measures may also be documented.

A second list contains the avalanche tracks subject to artificial release by the local avalanche service. The proposal or execution of artificial avalanche release may be documented and motivated.

All this information is put into the final documentation.

Figure 3 shows the list of facilities which are to be protected and the avalanche tracks subject to artificial release.

3.4 Documentation

The hazard evaluation process is concluded by printing out the filled-in form. Optionally, it may be saved on disk.

The parts of the form which are not completed are printed as a template which can be completed manually. This template will contain the station data, facilities and avalanche track list.

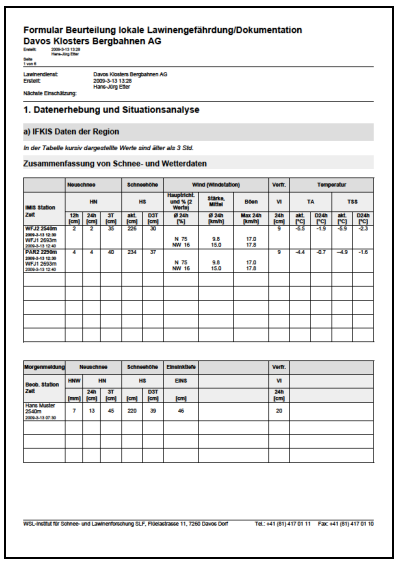
Formular Beurteilung lokale Lawinengefährdung/Dokumentation
Davos Klosters Bergbahnen AG
1. Datenerhebung und Situationsanalyse
a) IFKIS Daten der Region
In der Tabelle kursiv dargestellte Werte sind älter als 3 Std.
Zusammenfassung von Schnee- und Wetterdaten

Figure 1. Station data list

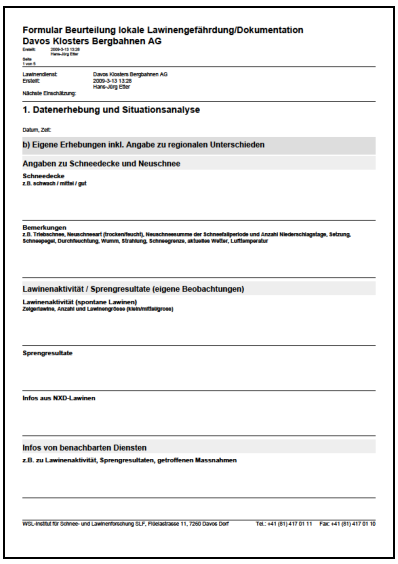
Formular Beurteilung lokale Lawinengefährdung/Dokumentation
Davos Klosters Bergbahnen AG
1. Datenerhebung und Situationsanalyse
b) Eigene Erhebungen inkl. Angabe zu regionalen Unterschieden
Angaben zu Schneedecke und Neuschnee
Lawinenaktivität / Sprengresultate (eigene Beobachtungen)
Infos von benachbarten Diensten

Figure 2. Evaluation form

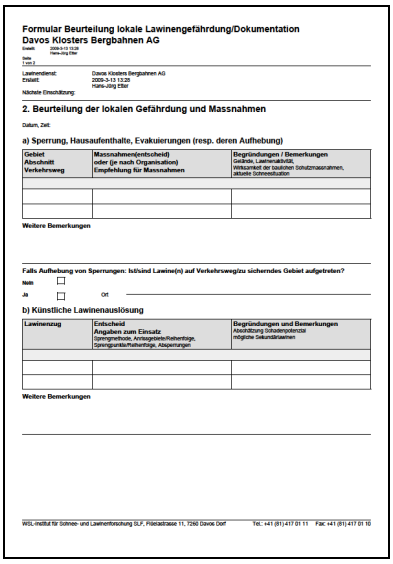
Formular Beurteilung lokale Lawinengefährdung/Dokumentation
Davos Klosters Bergbahnen AG
2. Beurteilung der lokalen Gefährdung und Massnahmen
a) Sperrung, Hausaufenthalte, Evakuierungen (resp. deren Aufhebung)
b) Künstliche Lawinenauslösung

Figure 3. Measures

4 USER FEEDBACK

We wanted to know whether IFKIS-EVAL provides local avalanche services with the information needed for efficient hazard estimation. For this purpose, a survey was created and sent to the users.

In the following, the results of the survey are presented.

4.1 The survey

The following questions were addressed:

- In which situations is IFKIS-EVAL being applied?
- How do local avalanche services work with IFKIS-EVAL?
- Does IFKIS-EVAL suit the needs of local avalanche services?
- What about usability?
- Will local avalanche services make use of IFKIS-EVAL in the future?

Surveys have been sent to members of 23 local avalanche services, 16 surveys were returned.

We want to point out that this survey is based on the use of IFKIS-EVAL in only one winter. Some of the local avalanches started using IFKIS-EVAL in the mid of winter.

4.2 User profiles

About 50% of the interrogated members of local avalanche services decide about and at least partly carry out safety measures themselves.

About 50% give recommendations about safety measures.

Some of them are members in several commissions or avalanche services and therefore fill in different positions with different competences. They were sent one survey.

4.3 Usage of IFKIS-EVAL

IFKIS-EVAL may be used in combination with other tools.

So, 62.5% of the interrogated users said to adopt IFKIS-EVAL in addition to other, mostly own forms. 37.5% by now work with IFKIS-EVAL only.

How often were the single modules in IFKIS-EVAL used in winter 2008/09?

The station data list (module a) is examined every time the application is started. The evaluation part (module b) is then worked through less frequently since it is needed only in critical situations. The safety measures part (module c) is completed even less and usually after filling in the second part. This workflow obviously is associated with the actual situation. Nevertheless, 37.5% of the interrogated users always com-

pleted the whole form while 12.5% were interested in the station data only.

The use of IFKIS-EVAL is correlated to the actual snow and weather conditions. The more critical the situation, the more often is IFKIS-EVAL applied.

87.5% of the interrogated users use IFKIS-EVAL during heavy snowfall, 43.8% said to adopt IFKIS-EVAL during warming periods or rainfall. The latter implies the danger for wet snow avalanches not all local avalanche services have to deal with.

IFKIS-EVAL is a web application which implicates its use online. But does this meet the needs of local avalanche services? It mostly does.

56.25% always fill in the form electronically, 18.75% always print out the form and complete it manually (e.g. after examination of the situation in the field). 18.75% combine the two methods based on the actual situation whereas 6.25% mentioned to only print out the actual station data.

4.4 Suitability

We wanted to develop a tool which meets the needs of its users and supports hazard estimation. In order to verify how good we met our goal, we asked them how good IFKIS-EVALS fits into their workflow.

80% said IFKIS-EVAL complemented their own forms, especially the summary of station data. 13.3% mentioned that IFKIS-EVAL and their own forms overlap, 6.7% said IFKIS-EVAL did not suite their workflow since documentation usually takes place later in the day and the workflow in IFKIS-EVAL requires immediate documentation of measures.

Complementing features mostly include station data, but also the possibility to list local facilities and avalanche tracks and documentation. Overlapping features consist in station data, evaluation and documentation. Considering that local avalanche services work with different tools it seems obvious that some features occur as complementing as well as overlapping.

And does IFKIS-EVAL really improve hazard estimation?

80% said their work got more efficient using IFKIS-EVAL, 13.3% do not see any difference in the time used for hazard estimation. 6.7% judged using IFKIS-EVAL got a good return although it was more time-consuming.

Efficiency is improved thanks to the customized station data list and the standardized form which has only to be completed. The form can be printed out, taken into the field and used for documentation purposes.

4.5 Usability

How to define usability? From our point of view, an application is user-friendly when its use is mostly self-explaining to its users. IFKIS-EVAL was created as a support tool, and as this it should make work easier. Did we succeed?

75% of the interrogated users said the handling of IFKIS-EVAL was simple, 25% judged it moderate. Some of them said it took some time to get used to it.

4.6 Features judged as good

For future development, we need to know which parts of IFKIS-EVAL are judged as good and therefore should not be touched.

Users mostly appreciate the customized station data overview. It allows them to gather information quickly and to focus on danger evaluation.

Thanks to the modular structure, the hazard estimation process can be documented, regardless of whether all parts of the form have been filled in or not.

The workflow system was judged as good. Hazard estimation always follows the same procedure.

According to some users, the form is clearly arranged.

The evaluation part consists of the questions to be addressed when evaluating the danger situation and has only to be filled in. This saves time and gives structure to the evaluation process.

The facilities which have to be protected and the avalanche tracks subject to artificial release show up on the form and can be customized. They do not have to be listed manually every time the danger situation is being evaluated.

4.7 Features subject to improvement

A save function was requested by several users. When hazard estimation is terminated, a PDF file is opened directly in an appropriate application and may be saved. The file may also be saved without opening it by applying the “Save As” function in the web browser. This did not come out clear enough.

Every time the form is opened, actual station data is retrieved and therefore included in the documentation. The workflow consists in working through the application at once. It is not possible to stop and continue the work later since station data and already made form inputs are lost after a certain amount of time. This does not reflect the workflow of several local avalanche services.

Often, station data is examined, hazard estimation is made and safety measures are realized instantly. Documentation then takes place

later in the day. At this moment, the original data is not available anymore. Reopening the form means that newer station data is included into the documentation and does not reflect the basis of the decisions anymore. It should be possible to save the form at a given state and edit it later.

The station data list shall provide some empty rows so that data from own stations may be added manually.

The form gives a complete guideline for hazard estimation. As a consequence, IFKIS-EVAL may seem quite extensive, especially in situations where a detailed estimation is not necessary. Of course, IFKIS-EVAL is structured into modules and not all parts have to be completed.

According to the different positions several members of local avalanches fill in, it can happen that they repeatedly have to report events or data. This redundancy has been criticized.

4.8 Technical aspect

Often technical questions arise where the programmer does not expect them. A web application may be tested on a variety of platforms and still problems may show up.

73% of the interrogated users experienced no technical problems.

27% dealt with problems, mainly with saving the documentation.

4.9 Use of IFKIS-EVAL in the future

Now that several local avalanche services had worked with IFKIS-EVAL for at least some months, we wondered whether they will use it in the future. We were happy to hear that everybody does.

53.3% will use IFKIS-EVAL exclusively, 46.7% will use at least some parts of it in combination with own forms: 85.7% of them will use the station data part, 28.6% will use IFKIS-EVAL for danger evaluation and 71.4% will use IFKIS-EVAL for documenting hazard estimation.

4.10 Summary

The users provided valuable feedback which will help us improve and continue the development of IFKIS-EVAL.

They mostly appreciate the station data lists, since it gives them a quick overview over the situation. Until now, members of local avalanche services had to gather station information one by one manually.

The evaluation part serves as a checklist and has only to be completed which gives structure to the hazard estimation process.

The custom lists of facilities and avalanche tracks are also appreciated.

Despite all advantages, IFKIS-EVAL constitutes one more tool besides others used for hazard estimation. Redundancy in reports of data or events can only be avoided by not completing the appropriate part in IFKIS-EVAL. In this case, however, the documentation lacks this information. The need for finding a solution to this problem has clearly come out in the survey.

5 FUTURE DEVELOPMENT

The need for saving the documentation form at SLF came out early. It goes together with the possibility to edit an opened form at a later time. At the moment, this is not possible due to session timeouts.

Customization of IFKIS-EVAL still is to be done manually by the administrator. Local avalanche services should be able to customize IFKIS-EVAL for their needs.

By now, different tools are being used for similar tasks. These tools have common parts and it is obvious that according to the user's role the same information has to be entered in different applications. Avoiding this multiple effort as much as possible should be our goal.

6 ACKNOWLEDGEMENTS

.The guidelines for avalanche control services provided a good basis for IFKIS-EVAL. Nevertheless, some work had to be done in order to get an appropriate implementation. We would like to thank our colleagues for their valuable help during the development of the form: Urs Anthamatten, François Dufour, Matthias Gerber, Hanspeter Hefti, Norbert Hildebrand, Jörg Kindschi, Roland Meister, Jakob Rhyner, Beat Rufibach, Jürg Schweizer, Thomas Stucki, Willy Werlen and Franz Werren.

We also would like to thank our users which provided valuable feedback during the test phase and in returning the survey.

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