Documentation and analysis of avalanche events

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ABSTRACT: Due to the rare occurrence of huge avalanches, documentation and analysis of these events is very important for the enhanced understanding of avalanche dynamics and processes. However, snow is a material that changes its behaviour and appearance very fast, and hence the documentation and analysis of such events should happen as fast as possible. In this paper the importance of the acquisition of well defined data for further recalculation and deeper analysis of the event is shown. Typical types of hazard features and damages are described, and an interpretation of these phenomena is given. The description, and in particular the correct interpretation of such phenomena, is very important for reconstruction and recalculation of the occurred avalanche process. Some experience was made in the avalanche winter 1999 and the need for standardization of documentation and analysis was shown. Since then a database and some standardization procedures have been developed in Austria, and nowadays different kinds of natural hazards are collected in this database in a standardized way. Education in documentation of natural hazard events is provided at the University of Natural Resources and Applied Life Sciences Vienna.

KEYWORDS: Avalanche documentation, Avalanche analysis, Avalanche type

1 INTRODUCTION

The documentation of natural hazards within the alpine range is characterized by a large quantity of information, which often lacks comparability and/or comprehensibility. Different responsibilities and “traditions” of data collection as well as unstandardized storage of event information pose difficulties in communication between organizations. This situation is further complicated by language barriers and heterogeneous viewpoints of different disciplines.

The efforts to standardize the documentation of Avalanche-, Rockfall- or Debris flow-events are old, and several proposals were made in the past (UNESCO 1981, Land Tyrol 1996, PLANAT 2006, McClung & Schärer 2006, DISALP 2007). The application of databases and new possibilities in calculation of such processes gives new importance to a standardized documentation. After the avalanche winter 1998/99 and the flood events of 2002 in Eastern and 2005 in Western Austria, we learned that documentation of such events can be strongly influenced by subjective interpretation of the person executing the documentation. To compare events, to classify and analyse them and to recalculate events some time later, a uniform standard of documentation is needed. Immediate documentation sometimes is not possible because of rescue and other on site operations. Documentation should be simple, and uniform checklists should support the person who is responsible for the documentation.

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2 GENERAL PRINCIPLE

2.1 Uniform standard

Documentation requires a standardization of data collection. This standard can be guaranteed, and regarded as the “least common denominator” of phenomena and characteristics that are to be recorded. The fundamental documentation which is based on this standard, allows a coherent data acquisition and a well structured recording, which can be used for a continuative and comprehensive analysis of the data.

A checklist and a blank form should guarantee adherence to this standard, in particular to help people with less avalanche education like hunters or foresters to document the event, because those people are often the first ones at an avalanche site. The blank form is divided into two main parts. The first part consists of a questionnaire to lead through a survey of eye witnesses, the second part has to be filled by own investigations.

The so-called basic documentation according to the 5W-standard comprises the most important parameters:

- information about the type of event (type of process, answer to the question WHAT)

- information about the date (answer to the question WHEN)
- information about the process area (answer to the question WHERE)
- information about the course and the chronology of the event, about the consequences and damages, about the risk management (answer to the question HOW)
- information about the weather conditions before and during the event, and about causes and triggering processes (answer to the question WHY)
- information about the observer (answer to the question WHO)

It is of vital importance to chiefly record those phenomena and characteristics which will be changed or removed by cleanup measurements. Yet no interpretation of processes is to be made, only the recording of phenomena and their characteristics.

The investigation methods are implemented by forms and checklists. Forms are focusing on basic parameters and usually give little room for any additional observation. Checklists can be designed much more extensively. It is left to national decision makers which standards of data acquisition are required. In any case, analogue notes must be easily transferable to a data base. Therefore, the checklists merely serve as a guideline for a uniform documentation of events. They can be transferred to forms after defining the requirements on the investigation.

2.2 5W+ Extended standard

The enhanced documentation is based on the basic documentation, but additional inquiries are made in areas of special interest. This could be avalanches that damage infrastructure or avalanches that are of special interest because of their typical phenomena. 5W+ Extended standard could also mean that some indicators are measured exactly and are not only estimated.

An enhanced documentation of events is less significant than the basic documentation. In most cases it is carried out by persons who work in the field of natural hazards and who are highly experienced in the documentation of events. This can take days or weeks. Nevertheless, emphasis should be placed on recording data which is subject to variation.

The extended documentation is based on the basic documentation, and thus is also a quality check. Again, no interpretation has to be made.

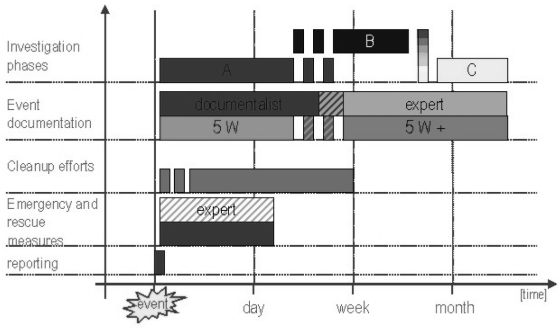

Figure 1. Scheme of the order of priority of investigations (DIS-ALP 2007)

In most cases 5W+ documentation will be carried out by persons who work in the field of natural hazards and who are highly experienced in the documentation of events.

2.3 Database development

All data are collected in a uniform database and are therefore available for any statistical analysis. The structure of the database follows the geomorphological avalanche classification published by the UNESCO 1981 (Avalanche atlas UNESCO 1981). The database is supervised by the Ministry of Agriculture and some efforts are made to summarize all documentations in this database. The main problem is that different organisations are responsible for documentation depending on its spatial and factual responsibility.

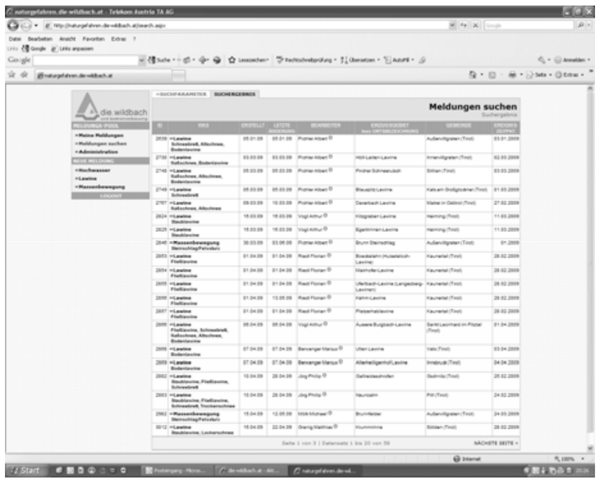

Figure 2. Avalanche data 2009, recorded in the Austrian database (extract)

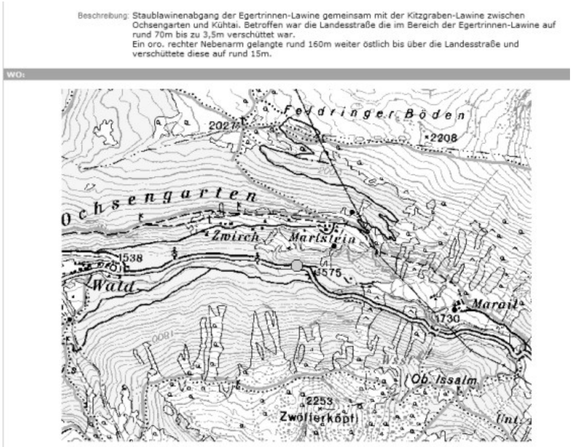

Figure 3. Avalanche spot, identified on the Austrian Basic Map 1:25 000; different colours mark different kind of natural events

2.4 Avalanche classification

The UNESCO avalanche classification (UNESCO 1981) is used for the basic structure of the data base.

3 KEY PHENOMENON – KEY PROCESS

Key processes are defined by key phenomena. This is one of the basic ideas of this kind of documentation. The interest of the person who performs the documentation should be focused on the phenomena or indicators that could be seen or recognised. Subsequently the second step is to reason from the indicator to the process. For example, if broken or thrown trees are found on the avalanche track at the avalanche site without any snow deposition, the corresponding process will be powder avalanche.

3.1 Process intensity

Different efforts have been made to describe the process intensity. Rapin (2002) presented a classification that is based on avalanche pressure. In avalanche hazard mapping in Austria the criterion for different hazard intensities is also based on pressure criterions. To follow the logic that the observer should "only" describe what he/she can recognise, the occurred pressure is a result of further analysis. What the documentalist can see, estimate or measure is the size of the area that is covered with avalanche deposition and also the depth of the deposition. These values are independent whether or not there are damages on houses or trees. Because of this reason, we decided to use the covered area and the depth of the deposition to define the process intensity. This is similar to other kinds of natural hazards, such as debris flow, where these criterions are also used for intensity analysis.

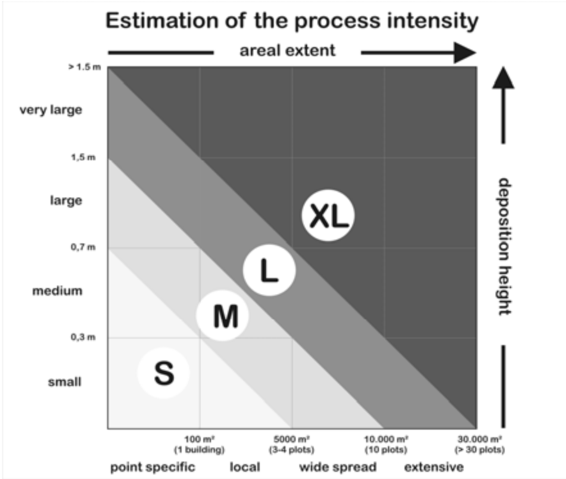

Figure 4. Estimation of process intensity

3.2 Description of phenomena

Typical phenomena are:

- Snow phenomena
- Vegetation phenomena
- Erosion phenomena
- Damage phenomena

Snow phenomena indicators are mostly found at the avalanche deposition, the starting area and the avalanche track. Type of avalanche fracture, reason of avalanche triggering, depth and density of fracture or deposition are as important as deposition depth, density, grain size or distribution.

Figure 5. Wet snow avalanche deposition

Snow documentation differs in some ways from documentation of other natural hazard deposition like rock fall or debris flow. In these cases, the transported mass is still available some weeks after the event, which is dissimilar to snow. Snow changes its consistence and behaviour very fast, and therefore snow documentation must be completed immediately after the avalanche event. This is sometimes difficult because of ongoing bad weather, ongoing avalanche danger or rescue operations as in Feb. 1999. Hence, documentation of naturally realised avalanches is sometimes impossible.

Figure 6. Clear distinction of powder snow and dense snow deposition

Vegetation phenomena are - for example - broken trees, broken branches of trees, thrown trees or broken tree tops. Transported remnants of grass vegetation or brushes gives some hints about the origin of avalanches. Cross profiles along the avalanche path gives valuable indication about avalanche frequency by analysing the age of thrown trees. Distinction of powder or dense flow paths are also often shown by vegetation.

Figure 7. Vegetation phenomena in the avalanche track; the powder part overflowed the terrain ridge on the left side of the avalanche track

Figure 8. Vegetation phenomenon; typical phenomenon for powder avalanches

Erosion phenomena are indicators for the origin of the avalanche and the depth of the fracture. Distribution of rocks in the deposition area covered with lichens and moss gives some information about avalanche frequency.

Damage phenomena are sometimes found on constructions like bridges or buildings. A detailed documentation of damages as a basis for post-event analysis is very important, because exact documentation of full-scale avalanche impacts on large structures are rare. Analyse results have to be considered in designing of constructions in avalanche prone areas.

Figure 9. Damages on a roof caused by powder pressure

Typical powder damages are damages to roofs or chimneys. Other signs of powder damages are for example, broken windows or destroyed doors. Investigation of constructions should not be limited to the avalanche faced front. Some damages may be found on the opposite walls. It is recommended to engage a stress analyst for analysing damages on constructions.

Of course, sometimes it is not easy and sometimes impossible to reconstruct the avalanche process by analysing damages. Nevertheless an exact documentation with the support of a stress analyst is needed. Documentation on constructions has to be undertaken as soon as possible, because some damages are easier to interpret in connection with snow phenomena as deposition form, density, grain size etc.

4 EDUCATION IN DOCUMENTATION

Documentation requires a tight planning of investigation, a selection of utilities and equipment prior to an event, and a documentalist that is immediately available. It is a key factor to minimize the time needed for the basic documentation. It is thus favourable to provide documentalists with checklists, quickly operable measurement systems, and appropriate instruments. Furthermore, it is of vital importance to train people for the event documentation. Hence a special course on documentation is offered to people with an interest in this topic at the University of Natural Resources and Applied Life Sciences Vienna. This course consists of lectures on the methodology of event documentation, mapping out of silent witnesses, an understanding of the legal framework, basics on disaster management and code of practice in communication. Additionally, on site documentation and mapping is exercised for different process types.

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