

# **CONSIDERATION OF THE EFFECT OF PROTECTION MEASURES IN HAZARD MAPS: THE SWISS APPROACH**

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## **INTRODUCTION**

In Switzerland hazard maps are of great importance. They are decisive for land use planning and are used to document the demand for protection measures and to illustrate their effect. Since 1951, for example about CHF 1.5 billion were spent on structural avalanche protection measures. Since the space that is unaffected by natural hazards is small in the Alps, structural protection measures are essential in order to allow extension of settlement areas. In the last years pressure was increased to authorities to reclassify hazard zones after protection measures were built. Therefore the question on how to consider the effect of protection measures is important for practical implementation. In Switzerland a unified strategy among all natural hazards is missing. In 2002 the “Specialists Natural Hazards – Switzerland (FAN)” group organized a workshop where experts from Switzerland and neighbouring countries had the chance to discuss and develop this topic. An outcome of the workshop was the set up of a project to develop a general procedure applicable to all natural hazards. The project started in 2006 and as a first result a procedure was elaborated which allows the assessment of the effect of protection measures.

## **REQUIREMENTS FOR PROTECTION MEASURES**

The main requirements in order for a protection measure to be considered in a hazard map can be summarized as follows:

- The effect of the measure has to be quantifiable. This makes it necessary to have on the one hand adequate process knowledge (basic principles, methods, etc.) and on the other significant experiences with the measure or scientifically proven facts on its effectiveness.
- Uncertainties should be as small as possible. A measure cannot be considered if the effect of the measure is smaller than the uncertainty of the hazard assessment.
- A protection measure can be considered if it is available permanently and if its design life is at least 50 years with a normal maintenance.
- Temporary measures such as artificial release of avalanches are not supposed to be considered.
- A protection measure can only be considered after the acceptance of the construction work.
- The assessment of a protection measures is based on scenarios with a 30, 100 and 300 year return period. In addition an overload of the measure with a return period of more than 300 years has to be checked.

If those general principles are fulfilled the effect of a protection measure can be assessed in four steps. Step 1 of the procedure contains a rough evaluation of the available information on

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the process and the protection measure. In step 2 the measure is evaluated by determining its reliability and failure probability on the basis of its structural resistance, serviceability and durability of the measure. Step 3 contains the assessment of the effect of the measure where the failure probability is the basis used to fix the determining scenarios for the hazard assessment. In the final step 4 recommendations are prepared for the implementation of the hazard map in land use planning.

## EFFECT OF SNOW SUPPORTING STRUCTURES

The quantification of the effect is one of the key-points in the procedure. The effect of the measure is assessed for different scenarios in relation of intensity and probability. The most important scenarios for supporting structures for example are (Fig. 1):

- Scenario 1 "avalanche release outside of the controlled area". The areas that are not controlled by structures are decisive.
- Scenario 2 "avalanche release inside the controlled area" is decisive if the structure height is chosen correctly and if most of the starting zone is controlled by structures.
- Scenario 3 "avalanche release over the filled up structures". The risk of overfilled structures depends on the chosen structure height and the expected extreme snow height.

On the basis of the 3 scenarios the reduced runout distances of the avalanches can be calculated with avalanche dynamics models. In very uncertain situations, e.g. if no long-term observations of snow depths and avalanches are available or in the presence of large secondary starting zones, the hazard maps should be adapted very carefully.

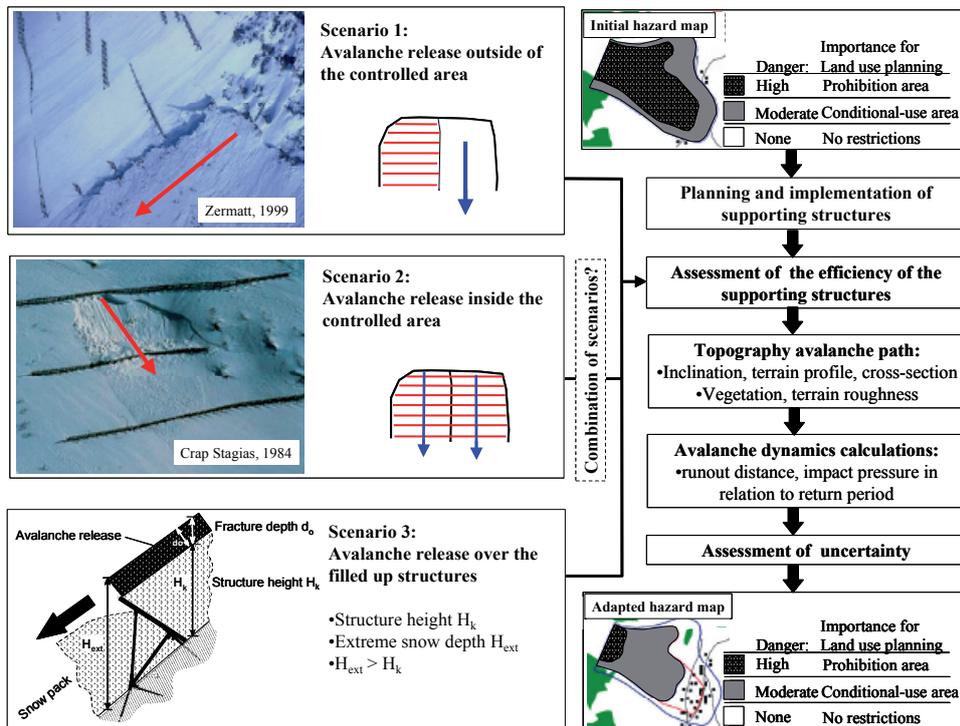


Fig. 1: Procedure for the quantification of the effect of snow supporting structures.

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