Natural Hazard Risk Management along Transport Routes in the Alps

The mountains have been drilled through, the precipices bridged. High quality roads extend up to the highest and most remote mountain valleys, extensively used rail tracks and mountain railways criss-cross the Alps. However, despite decades of effort and the investment of millions in protective measures, it is impossible to provide complete protection to transport routes against the hazards posed by avalanches, floods and mass movements. Large-scale natural forces continue to pose considerable risks in the Alpine region in particular. On the other hand, it is the responsibility of the local, regional or national authorities to ensure that these transport routes remain available and safe to use even under difficult conditions.

To ensure that this gap between natural conditions and society’s needs and requirements, which can never be completely bridged, does not become too wide, eventual areas of conflict must be identified in good time and resolved with the help of suitable measures. However, in many cases, the information available is insufficient to facilitate informed debate about the risks that actually exist and to enable well-founded decision-making. The responsible authorities and infrastructure operators repeatedly face a crucial problem in relation to risk management: they often have insufficient information about the relevant natural hazards and the probability of their occurrence. The same applies to the damage that these hazards may be expected to cause. Here too the information available is simply not comprehensive enough.

For this reason PARAmount* is being carried out as part of an international cooperative project involving Austria, France, Italy, Slovenia and Switzerland. The project, which was launched in 2009 and will run until 2012, concerns the transport routes in the Alpine region that are already at risk from natural hazards and may become even more vulnerable in future due to the effects of climate change. The aim is to develop more effective and sustainable protection strategies in the context of an international exchange of experience. The primary concern here is to adapt existing methods and tools to the special requirements of the Alpine region and to make them available to local or regional bodies in a form that is tailored to their capacities and requirements.
Use uniform terminology
The different countries, transport companies and participating institutions and companies have developed a variety of methodological approaches for risk analysis, risk assessment and the planning of hazard protection measures. The terminology used as part of these approaches also varies and it is not uncommon for terms to be understood in different ways. This diversity creates problems of comprehension and makes it more difficult to implement the desired exchange of experience.

Recommendation
To facilitate the exchange of experience, the different countries, transport companies and participating institutions and companies should use standard terminology (or the terms used should, at least, be clearly defined in a glossary).

Prioritise relevant risks
The budgets available to the operators of transport routes and infrastructure for risk analysis and the risk-based planning of hazard protection measures are usually limited. The expenses incurred should be proportionate to the cost of the risk-reduction measures undertaken on the basis of such analyses and planning.

Recommendation
The smaller the budget available for risk-related studies, the more appropriate it is to limit the measures taken to the main hazard types or route sections. It may also make sense to limit the measures to the relevant risks in an initial phase and then focus on other factors in a second phase.

Take local knowledge into account
Natural hazards are often characterised by the fact that the risks they pose vary significantly at both regional and local level.

Recommendation
If possible, all of the knowledge and information available at local and regional level and the corresponding documentation should be taken into in the risk analyses. This applies, in particular, to the experience gained and recorded in the course of previous hazard events.

Consider availability
In addition to the protection of travellers and the material assets associated with transport infrastructure, the availability of transport routes or systems is an important risk management criterion.

Recommendation
As part of the risk-based planning of hazard protection measures, it is necessary to establish clearly and in good time whether the closure of routes will be considered as a measure (or, indeed, not). If route closures are at all possible, suitable indicators should be defined for the assessment of this measure. The product of the duration of closure and the normal traffic volume is a particularly useful indicator in this context. Other indicators could include the number of missed journeys or the cumulative length of the diversion routes.

Complicated and expensive measures – for example the construction of new hazard protection structures – are particularly justified if the availability of a transport route or system is a key priority. This applies, in particular, to railway lines and access roads (see photo left). However, if the permanent availability of a transport route or system is not essential and a degree of interruption is tolerable, less expensive ways of reducing risks can usually be found, for example the implementation of warning and alerting systems.

Decision makers in the transport sector are not usually natural hazard experts. Therefore it is all the more important to develop and make comprehensible decision-making documentation, relevant mapping models and user-friendly simulation models available to them. The resources available for protection against natural hazards are generally limited and there is no way of providing absolute safety in the face of these hazards. Hence, it is always necessary to discuss the acceptance of risks and the proportionality of hazard protection measures: What can be allowed to happen, where can it be allowed to happen?

What the Risk Management Tools and Methods Need to Do*

* Based on the results of an international workshop (held on 16 – 17 June 2010 in Zurich) on the status of knowledge and practice of risk-based decision making for protection against natural hazards along transport routes in the Alpine region.
A level of safety that is socially acceptable, economically proportionate and legally reliable should be achieved in individual cases. This strategy for protection against natural hazards is based on comprehensive hazard and risk assessment and forms a closed cycle, in which preparedness (prevention), response and regeneration complement each other (see diagram left). Hence, model calculations and computer simulations that are suitable for practical use are increasingly being used in the planning of hazard protection measures. Representative scenarios about the possible course of risk events can be created and further developed with the help of such instruments.

Allocate marginal costs
In contrast to risk analysis, which largely follows objective rules, the evaluation of risks involves numerous subjective decisions.

Recommendation
A proven way of evaluating risks is the allocation of marginal costs to certain damage indicators, e.g. EUR 5 million per fatality. Risks can be monetised in this way and compared with the cost of protective measures (cost-effectiveness analysis) An approach of this kind enables the risk-appropriate and economically effective investment of the limited resources available for safety measures.

Accept uncertainties
Numerous recognised methods and tools (e.g. simulation programs) now exist for the analysis of the risks posed by natural hazards. However, some uncertainties remain that are not necessarily resolved by increasing the level of detail of the analyses.

Recommendation
If possible, risk analyses should be verified for plausibility on the basis of hazard event statistics. This approach can be particularly successful if entire networks of transport routes can be analysed using the same method. However, this necessitates the consistent recording of event statistics by the route operators. This information should include the damage and closures caused by each hazard event.

Take climate change into account
Whereas the trends for some climate-relevant parameters can be estimated (e.g. mean temperatures, or the shifting of permafrost areas to higher altitudes), the trends for other parameters are currently very difficult to predict (e.g. extreme wind and precipitation values).

Recommendation
Despite the limitations of the information currently available and the associated uncertainties, in the case of very long-term decisions on hazard protection measures (e.g. the construction of complex and expensive protective structures), the foreseeable risk-relevant climate trends and their consequences should be adequately taken into account.

Foster risk acceptance
Risk-based decision-making tools are not effective if they are not understood or accepted by the decision-makers.

Recommendation
Decision-makers should be present during the development of these tools, at least occasionally. It can help if the risk analysis is initially implemented on a simplified and pragmatic basis, even if this involves the acceptance of certain curtailments in terms of scientific detail. Switzerland has had positive experience with IT-supported tools that promote risk dialogue and possible risk-reducing measures (e.g. RiskPlan, see back page).
RiskPlan is a computer-based calculation and management tool that can be used for a range of purposes in both practice and training. It provides, first, a rapidly accessible overview of the risk situation in a particular area (i.e. commune, region or canton). Second, it demonstrates the possible scope of the damage that natural hazard events may be expected to cause in the area and the costs that would arise for measures to provide protection against such hazards. This comparison enables the approximate estimation of the cost-effectiveness of such measures. In addition, RiskPlan can be used to compare risk situations in different locations and, similarly, the use of different safety measures. Finally, RiskPlan also enables the verification of safety approaches that are already being implemented, i.e. through the comparison of the risk situation before and after the implementation of particular hazard protection measures.

The corresponding results, which are presented in graphical form by RiskPlan, provide a valuable basis for a comprehensive and broad risk dialogue. In addition to the effect of various climate scenarios, all of the available hazard-related scenarios, irrespective of the source, i.e. hazard or intensity maps, event documentation, expert knowledge and experience and local knowledge – is incorporated into the calculations.

This pragmatic approach has the advantage that natural hazard and construction experts, the representatives of the authorities and insurance companies, members of the fire brigade, police force and civil protection services, and local experts can exchange and jointly evaluate their experience in a direct and undiluted form. This fosters trust and makes it possible to implement broad-based solutions for the remediation or reduction of risk situations.

The risk is calculated on the basis of the probability of occurrence of a particular event multiplied by the damage it would cause:

- **Major risks are not tolerated**
- **Medium risks should be reduced**
- **Minor risks should be accepted**

### Switzerland’s Contribution: Pragmatic Risk Management with RiskPlan

### PARAAmount Project Partners

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- Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW), Vienna

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- WSL Institute for Snow and Avalanche Research (SLF), Davos

**France**
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- Autonomous Province of Trento, Department of Civil Protection and Infrastructures, Trento
- Regional Agency for Environmental Protection and Prevention of Veneto Region
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