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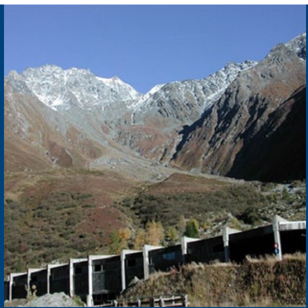
Integrated Disaster Risk Management in a mountainous area:

Field visits in the Canton of Valais, 21 May 2014



Field visit 1
Cross-border cooperation in applied disaster risk management along the transnational route of the Great St Bernard (Italy–Switzerland)

Field visit 2
Management of natural and technical risks (floodplain of the river Rhone/Monthey)

On the occasion of the 2nd Preparatory Meeting of the 22nd OSCE Economic and Environmental Forum

Editorial

The Swiss OSCE Chairmanship 2014 welcomes you to Switzerland on the occasion of the 2nd Preparatory Meeting of the 22nd OSCE Economic and Environmental Forum being held from 20 to 21 May 2014.

For the 22nd OSCE Economic and Environmental Forum, consisting of two preparatory meetings and a concluding meeting in Prague, Switzerland has chosen a new approach: we intend to link presentations and debates in conference rooms with practical observations in the field, while bringing people together to share their knowledge and expertise.

Countries in the OSCE region are frequently affected by floods, storms, earthquakes, drought and other natural hazards. The field visits in the Canton of Valais will demonstrate and serve to promote how comprehensive disaster risk management can be applied. We also seek to step up the exchange of good practices between OSCE participating States, and to raise awareness of shared responsibilities within national and sub-national participating authorities, as is the case between federal, cantonal and communal authorities in Switzerland.

Against the backdrop of ongoing global discussions related to reducing disaster risks and achieving development goals, we intend to single out three elements that are relevant for the OSCE as a regional arrangement in line with chapter VIII of the Charter of the United Nations:

- Tensions and crises may affect international peace and the security of nations and communities. To avoid this, the solution seems to be simple: **prevention is better than cure.** However, the shift from response to a combination of prevention and preparedness, response and recovery is a political challenge involving different policy sectors and stakeholders at multiple governmental levels. There is a growing trend towards this shift in the field of disaster risk management including all governmental entities, the private sector and the civil society.

- Pursuing a **comprehensive risk management approach, including disaster risks,** is in accordance with the multi- and cross-dimensional nature of the OSCE. Disaster risk management is therefore relevant for the OSCE's overall safety and security agenda. Not only because natural hazards may endanger people's lives and livelihoods, cause economic losses, or have a devastating impact on critical infrastructure, but also because cooperative mechanisms in reducing disaster risks may contribute to clearly defining responsibilities between nations, communities and people that are potentially at risk. The spreading consensus with regard to comprehensive disaster risk management could furthermore inspire the overall management of safety and security issues.

- The time has come for OSCE participating States to show **political leadership** at the global level and to commit to integrated disaster risk management as a contributor to achieve resilience of communities and nations. The ties between Geneva, New York and also Vienna must be strengthened, especially as we move ahead with preparations for the 3rd World Conference on Disaster Risk Reduction in Sendai, Japan, in 2015 (this year, Switzerland is hosting the two preparatory committee meetings for Sendai). The global community is furthermore gearing up to define new development goals that will include the reduction of disaster risks as well.

To adapt to a world of emerging challenges – such as the management of natural disasters – a regional security organisation such as the OSCE needs to shift from response to comprehensive risk management. This means developing a shared, broad understanding of the risks that lead to stress and shock, tensions and crises. The organisation has to work across institutional borders to prioritise and manage them comprehensively. The OSCE is well placed to offer a platform for such a dialogue as it understands safety and security as a cross-dimensional endeavour, which also covers natural and environmental risks. Developing coherent risk management strategies and assisting participating States in implementing them provide the OSCE with promising scope for engagement.

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1 Introduction

The integrated disaster risk management field visits on 21 May 2014 are organised in conjunction with the 2nd OSCE Preparatory Meeting of the 22nd OSCE Economic and Environmental Forum in Montreux, Switzerland. The field visits and its tour guide booklet are a collaboration of the Swiss Confederation and the Canton of Valais. The tour booklet incorporates some sections of the brochure that was prepared to accompany the field visits held on 24 May 2013 at the "Global Platform on Disaster Risk Reduction GPDRR". The booklet first provides a general overview, including a brief presentation of the Swiss context (chapter 2) and the principles of integrated risk management (chapter 3). This is followed by a description of each of the planned field visits (chapters 4 and 5).

The two field visits will take participants along the route leading to the Great St Bernard tunnel (field visit 1), a major international transit corridor linking Switzerland and Italy, and to the Monthey region of the Rhone valley (field visit 2), whose chemical industry makes it the economic motor of the Canton of Valais, but which is also particularly vulnerable to seismic and hydrological risks. Detailed information is provided in the factsheets found in Section 4 (field visit 1) and chapter 5 (field visit 2).

A separate factsheet has been prepared for each station of the two field visits. Each factsheet briefly gives a background and presents the challenges and opportunities related to natural risks; it then gives an overview of the prevention and preparedness measures that have been taken to mitigate risks.

Lastly, the appendices at the back of the booklet provide a list of acronyms, a glossary of the terms used and useful links for those interested in knowing more about the various issues.

2 Background

Switzerland: a mountainous country

Switzerland is a landlocked country with an area of 41,290 km^2. Geographically the country is divided into the Alps (about 60%), the Swiss Plateau and the Jura (mountain ridge in the north-west). The Swiss population (about 8 million) is concentrated on the Plateau, with the largest cities Zurich, Bern, Lausanne and Geneva. Approximately 73% of people work in the service sector, 24% in industry and 3% in the agricultural sector.

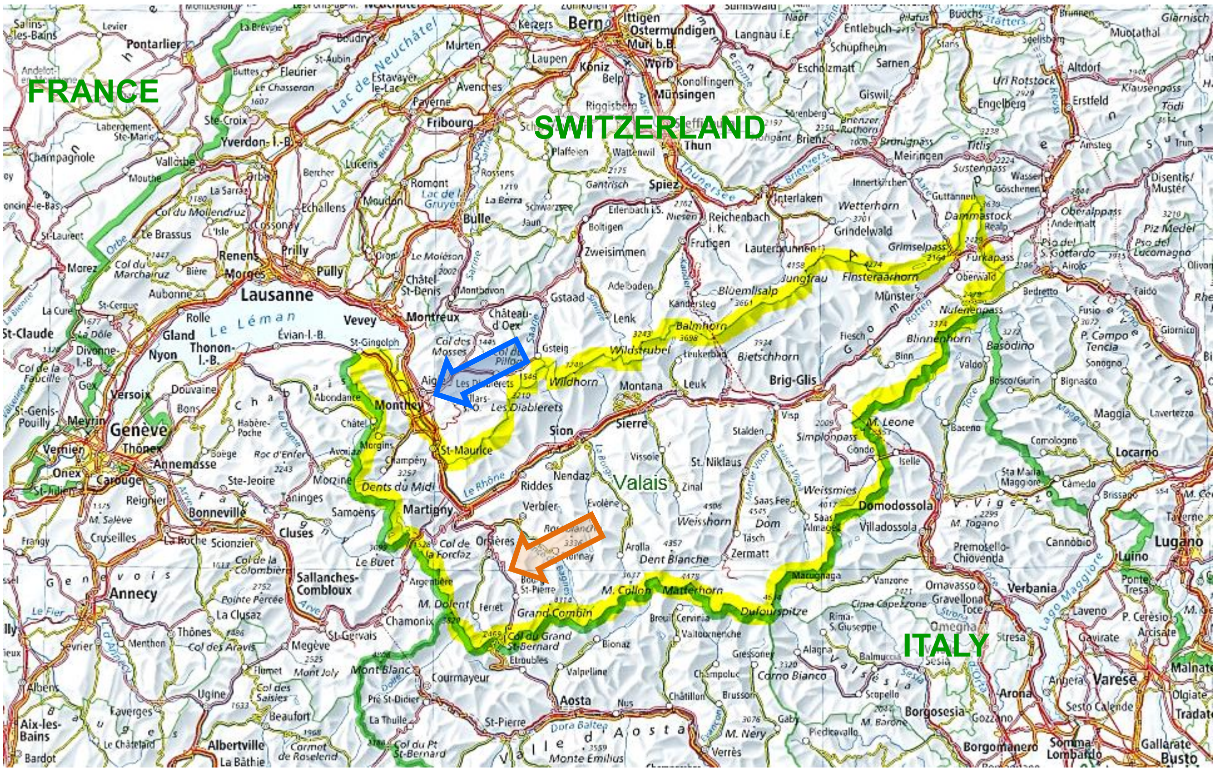


Figure 1: Detail of a map of Switzerland, showing the Canton of Valais (yellow boundary) with the city of Monthey (blue arrow) and the international corridor between Switzerland and Italy (orange arrow) (geodata©swisstopo).

Switzerland is divided into 26 cantons (~districts) and a total of 2,352 communes (~municipalities). Activities in the field of disaster risk management (DRM) are supported by the Confederation/federal administration (mainly the Federal Office for the Environment: prevention and mitigation; and the Federal Office for Civil Protection: preparedness). The implementation of DRM measures falls within the remit of the cantons. The communes have the responsibility for the safety and the security of the population at local level; many communes are directly responsible for integrated DRM (with the technical and financial support of the cantons and the Confederation).

Confederation (state level)	Canton (district level)	Commune (municipality level)
- responsible for legislation, strategies, guidelines, recommendations, inventories - examines and approves protective measures: prevention, mitigation and preparedness - supervises/supports measures financially - monitors, warns and alerts	- ensures implementation of protective measures: prevention, mitigation, preparedness - allocates financial resources - structural planning - emergency management	- assures the safety and security of the population in the commune - land use planning - implements measures at a local level - local emergency management

Figure 2: Overview of governmental task sharing in DRM in Switzerland.

Being a mountainous country, Switzerland has a long tradition dealing with floods, landslides and avalanches. In the 1870s legal provisions were introduced to prevent the negative impact of disasters. The protection of forests was one of the cornerstones of the legal framework. Major disasters in the 19th century provoked intensive disaster risk reduction (DRR) activity, particularly engineering works to control rivers and streams. However, during a long period between the 1920s and the 1970s without major disasters, management strategies focussed on hazard prevention only. Major flood events in 1977 and 1987 brought about a complete change in thinking, from a sectoral to an integrated approach of disaster risk management, combining new legislation, new strategies and new concepts. The analysis of a series of subsequent disasters (floods, debris flows, landslides, storms and avalanches) occurred in 1993, 1999, 2000, 2005, 2007 and 2011 served for reviewing and improving the new strategies.

Canton of Valais: climate, geology and socio-economic conditions

The canton of the Alpine Rhone Valley covers 5,224 km^2. The river Rhone is seen as the 170 km long backbone of the Canton of Valais, with several major tributaries draining northern and southern valleys. The altitudes range from the glacial areas with summits reaching 4,634 m alt. (Dufour Peak) to a dry steppe-type climate at the southern foot of the slopes near the bottom of the valley (lowest point: 372 m alt. at Lake Geneva). This important relief results in a high precipitation gradient ranging from > 3,600 mm/a to < 600 mm/a in the Central Rhone Valley. A considerable part of the precipitation falls as snow.

The Alps developed as a result of the collision of the African with Eurasian tectonic plates. Rocks from oceanic deposition environments are found between continental formations. This staging occurs more or less in parallel to the Rhone Valley, highlighting the large fault zone of the Rhone-Simplon line. Intrusive granitic outcrops are found at the two extremities of the valley: the Mont-Blanc and the Aar massif. This very complex setting, combined with stress development during the creation of the tectonic sheets and continuing seismicity are responsible for a high density of natural hazards. Glacial advances (Ice Age, Little Ice Age) have strongly impacted the landscape. Current operational practice must deal with these landforms and deposits from a geological and geotechnical standpoint.

Switzerland's average per capita GDP is at about USD 80,000. The cantonal GDP is well below the country mean. One quarter of the economy of the Canton of Valais is based on the secondary sector (chemical and aluminium industry) and another quarter on tourism. Energy production (mainly hydroelectricity) sustains 10% of the economy; agriculture accounts for about 7%, which is much higher than the Swiss average. To enable workers to commute to factories and tourists to visit the resorts, a dense transport network to the tributary valleys has been developed (4,198 km of roads).

Climatic changes have an impact on the environment, the economy and the society. In Switzerland, rising temperatures and changing precipitation patterns are affecting surface water, terrestrial ecosystems and biodiversity: the glaciers are melting and the slow thawing of the permafrost is causing a reduction in slope stability in the steep areas of the Alpine valleys. Dry periods in summer are becoming more frequent and longer. The habitat of Switzerland is changing, and livelihoods with it. Science reveals how human activity influences climate change and enables us to implement measures to reduce our vulnerability and to prepare for the inevitable consequences. Changes must be recognized, anticipated and interpreted correctly: appropriate measures must be planned and initiated at the right time and to the right degree.

3 Integrated disaster risk management cycle

Switzerland has a long history and experience in dealing with natural hazards. However, it only became clear in 1987 in the aftermath of major floods that structural measures alone are not sufficient to guarantee protection. Since then spatial planning (master planning and land-use planning) to ensure sustainable and hazard-conscious land use has become much more of a priority. The idea that sufficient space must be given to watercourses has also become widely accepted.

Furthermore, recent events have shown that modern protection concepts can significantly help to limit damage: robustly designed protection structures conceived to cope with excess loads are key elements of successful prevention. Moreover, the damage caused by floods can be reduced by around a fifth if the authorities issue timely warnings and alerts and people assume individual responsibility to take suitable measures to protect their lives and property.

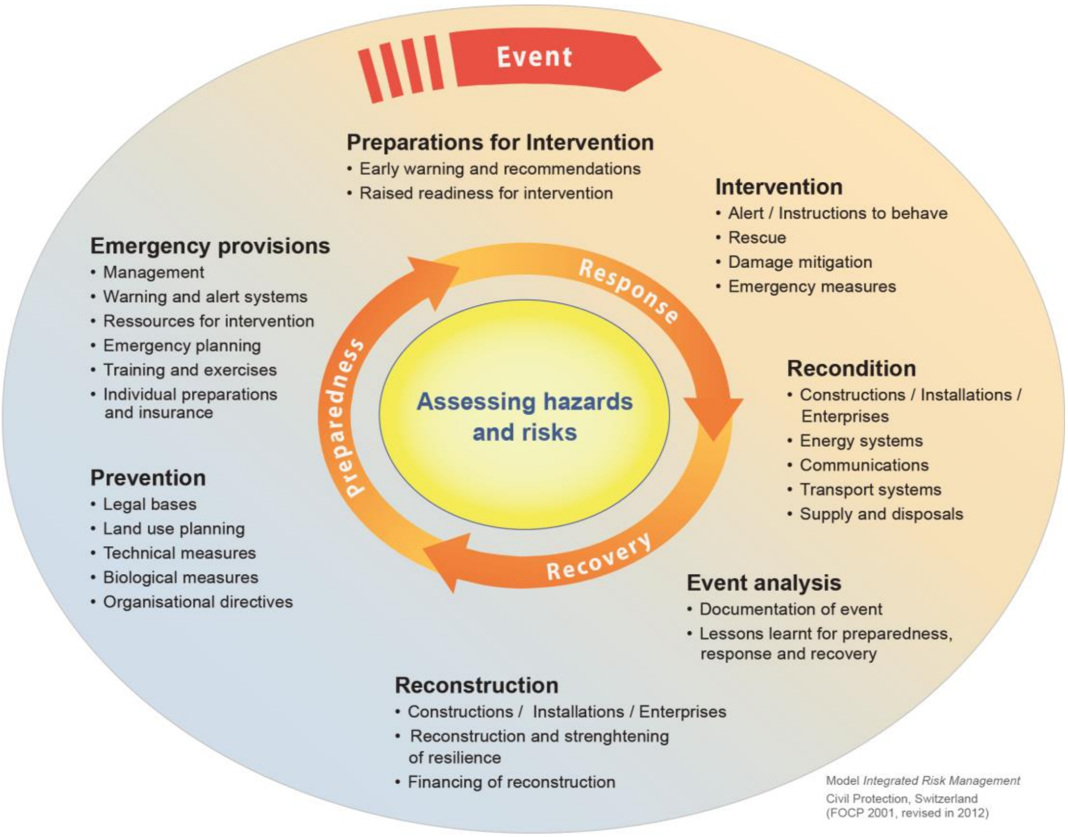


Figure 3: The integrated disaster risk management cycle.

Based on these learning processes, Switzerland developed an integrated DRM approach in order to achieve a level of safety which is ecologically acceptable, economically viable and socially acceptable (Figure 3). The principle of DRM combines structural, biological and land-use planning and preparedness measures alongside insurance cover. Whereas comprehensive hazard fundamentals are central to the approach and prevention and preparedness, response and recovery are the main complementary parts.

Assess and know your risks

Central to the integrated DRM cycle are hazard and risk assessments. A society can only deal sensibly with natural hazards if it has an in-depth knowledge of the hazards and risks, assesses them objectively, takes preventive measures and reacts quickly and correctly in the event of an emergency. Therefore, hazard fundamentals (incl. event analysis to support economic viability in resilience-building) are of primary importance for effective and efficient DRM, all the more as they are highly relevant for climate change adaptation.

Hazard assessment is relevant to determine the magnitude and frequency of environmental processes in affected areas, taking into account existing protective structures. The result of the hazard assessment is represented in a hazard map. The results of assessments and simulations are compared with the records of previous natural hazard triggered disasters. Usually, authorities at a municipal and district level call for a hazard and risk assessment.

Increase your investment in prevention

In the phase before an incident, prevention and mitigation measures and measures to cope with an incident (preparedness) are taken. Prevention pays. Investment in disaster risk prevention protects lives and livelihoods, public assets and private property. It pays on a large scale as it minimises the vulnerability of people and material assets to natural hazards. On the one hand damage is primarily avoided by risk awareness and an appropriate land-use planning based on hazard and risk mapping. Where it is not possible to avoid hazards structurally, technical measures (dikes, dams, etc.) or respectful biological measures (silvicultural and eco-engineering measures), maintained through a dedicated budget must be taken with a view to minimising the intensity of the hazard or protecting the objects at risk. On the other hand damage is avoided by managing and coping with the disaster. Preparedness measures are provisions for emergency situations that can occur and must be managed. Examples of such organisational measures are the implementation of warning systems, emergency intervention and rescue planning, training and public simulation exercises and purchasing insurance for house owners.

Respond to adverse events

Response measures planned in the preparedness phase turn into action when the incident becomes real. They help to cope with the incident and to manage its consequences. These measures are intended to limit the consequences and the duration of a disaster.

During the response the population is instructed on how to behave, victims are rescued, people and goods are evacuated and emergency measures are implemented to prevent further negative impact of the incident. Monitoring of the unfolding triggering event is increased.

Rehabilitation measures are launched after the intervention to ensure secure emergency operation of key infrastructures such as roads, communication systems and water supplies.

Ensure recovery while reducing risks

The intervention is followed by the recovery and reconstruction phase. Recovery measures consist of event analysis (what to learn from the event? how to rebuild better?), the adaption of hazard and risk maps, amendment of risk and disaster related laws, standards and procedures, retrofitting and reconstruction of buildings, critical infrastructures and services, and appropriate public awareness campaigns.

The event analysis studies and documents the development of the disaster and its consequences as well as the rescue operations. Evaluating disasters helps to understand the development of an event and its consequences. It is important that the first results of the disaster analysis are available as soon as possible in order to plan reconstruction. The previous shortcomings should be avoided during reconstruction. The main task is to correctly convert the results of the disaster analysis into lessons learnt and to integrate them into planning. The overall goal of recovery is to increase communities' resilience and reduce the vulnerability of systems with regard to conditions before the event.

4 Field visit 1: Cross-border cooperation in applied disaster risk management along the transnational route of the Great St Bernard (Italy-Switzerland)

General introduction

The focus of this field visit is on the interface between the most frequent natural hazards in mountainous regions, including rockfalls, avalanches, and debris flows, and the interests at stake in the transport of goods and people across a narrow Alpine corridor – the Great St Bernard Pass – which connects two border regions (the Valais and the Aosta Valley), providing a link between northern and southern Europe through Switzerland and Italy.

This transit corridor through the Alps – in use for centuries as a mountain pass, located at 2,469 m alt. – took on a new international dimension with the opening of the Great St Bernard tunnel, construction of which began in 1958. Because it is a binational undertaking, an international convention was needed to make construction and operation of the tunnel possible. Opened for use on 19 March 1964, the tunnel this year celebrates its 50th anniversary. This was the first tunnel to pass under the Alps, making trans-Alpine road traffic possible all year round. With traffic currently at over 600,000 vehicles per year, close cooperation between the two countries is indispensable not only for ensuring the proper functioning of the tunnel, but also for securing the entire route on both sides of the border (access road and tunnel), and for organising a coordinated response as effectively as possible in the event of a disaster.

Cooperation between Switzerland and Italy is very close and has continued now for many decades, thanks to the creation of an Italian-Swiss Joint Committee. Created at the outset of the project, this committee has acted as the body responsible for ensuring proper implementation of the convention on the tunnel, in keeping with legislative developments in the two countries, particularly in the areas of transportation, customs, and taxes.

On this field visit, we will stop at different stations along the route leading to the Great St Bernard tunnel, where various types of natural hazards have shown their effects in recent decades. At each station we will give a presentation showing how the integrated risk management strategy was put into effect in order to achieve implementation of structural and non-structural prevention and preparedness measures. The field visit will highlight, in particular, the importance of obtaining precise and objective information about potential hazards and risks, but we will also focus on the advantages of taking an integrated approach, particularly in cases such as that of an international transit corridor.

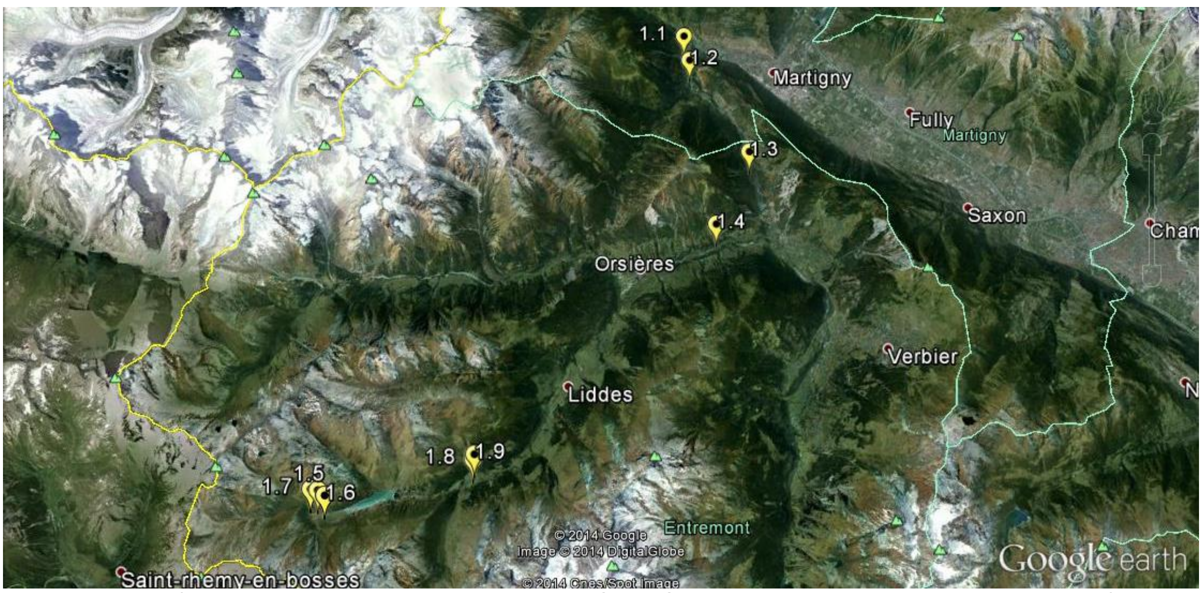


Figure 4: Map of the region between Martigny and the Great St Bernard tunnel, showing the location of the various stations of the field visit (yellow marking).

4.1 Lavanchy gallery: structural protection against avalanches, debris flows, and rockfalls

Background

Just off the Martigny exit, the Lavanchy corridor poses a first threat to the Great St Bernard highway, with a risk of avalanches and debris flows. In October 2000 (period with intense rainfalls all over the Canton of Valais), the old protection gallery showed its limits, as debris overflowed directly onto the road. An initial study, conducted after the event, showed that the gallery would need to be widened in order to allow debris flows and avalanches to pass over it. Originally, the dimensions of the gallery and the retaining walls had been calculated to allow the flow of avalanches to pass and to enable them to withstand the additional weight brought by avalanches or debris flows. Further studies were needed, however, in order to take into more detailed account the different possible scenarios in which debris flows from the Lavanchy corridor gave rise to rockfalls and to jamming in the river Dranse.

Challenges and opportunities

Based on those studies, certain improvements had to be made to the gallery, in order to deal with the following risks: i) overloading of the gallery during major debris flows (very rare), ii) impact of rockfalls on the gallery, iii) effects of debris flow transit and erosion on the gallery, and iv) jamming of the river Dranse caused by debris flows. The parameters for each of these hazards were quantified in order to design the appropriate measures.

Prevention and preparedness measures

In terms of the hydraulics, the phenomenon of jamming in the river Dranse was not exacerbated by the renovation work on the gallery. Nevertheless, an additional study showed that further backfill would be needed on the sides of the gallery (indicated by red arrows in the drawing, Figure 5), in order to prevent rocks from falling on the road. Containing the erosion caused by debris flows made necessary the installation of concreted ripraps at the most sensitive points. Finally, modifications were made to the general path of the gully of Lavanchy, and to the retaining walls on the right bank upstream from the gallery, in order to guarantee a freer passage of the debris flows.

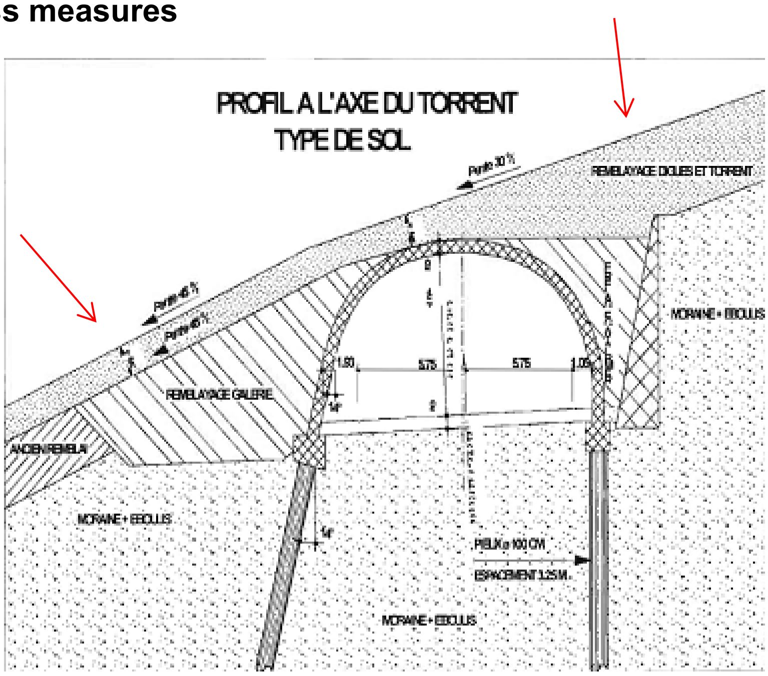


Figure 5: Profile view of the Lavanchy gallery *at the center line of the torrent (red arrow: backfills to consolidate the gallery).*

Participating authorities

Planning and execution of construction were supervised by Federal Office for the Environment (FOEN) and the Cantonal Road, Transport, Construction and Environment Department (SRTCE), with the assistance of engineering consultancy firms from the private sector.

4.2 Infrastructure at debris flow risk from the torrent Durnand

Background

At 8 km to the south-east of the municipality of Martigny flows the torrent Durnand, a tributary of the river Dranse. It originates from the *Liapeys de Grônes*, a former glacial cirque located at 2500 m alt.. In the local dialect, "liapeys" means "scree".

On 25 July 2006, a few surges of debris flow, triggered by the covered glacier of the *Liapeys de Grônes* (Figure 6, right), flowed into the torrent Durnand and hit the railway bridge connecting Martigny and Orsières shortly before the train passed. Luckily, there were no casualties, but the train and the tracks were damaged (Figure 6, left). Around 30,000 m^3 of debris clogged the bed of the river Dranse and created a lake that extended 200 m upstream. Given the subsequent danger of flooding due to the breakdown of the natural dam created by the deposit, 2,500 people in the city of Martigny had to be evacuated for a few hours.

Figure 6, left: Debris flow deposit on 25 July 2006, which jammed the river Dranse and impacted the train/railway and a small bridge. Right: The covered glacier area.

Challenges and opportunities

Debris flows are triggered either by rain fall or by snowmelt and promoted by global warming that changes the risk situation and requires adaptations. The torrent Durnand crosses the international Great St Bernard transit road, the railway leading to the Verbier ski resort and a major oil pipeline. Of further major concern is the possible occurrence of a cascade incident due to damaged pipeline infra-structure. Another danger is the high risk of flooding of a part of the city of Martigny in the event of a debris flow event similar to the one that took place in 2006.

There was no systematic registry of debris flow events for the torrent Durnand in 2006. The railway company reported only one single event on 12 July 1991. However, upstream of the catchment, some gullies showed traces of debris flow. These traces were not precise enough to evaluate the probability of occurrence and frequency of a debris flow. The challenge is to deduce the event frequency where no registry of events exists and to take new processes related to climate dynamics properly into account, such as the lower altitude limit of permafrost.

Prevention and preparedness measures

After the event of 2006, the Canton of Valais began to study the paraglacial area, source of the debris flows. The tools elaborated by the study are a hazard map and an emergency plan. Alongside the scientific study of the triggering area, the following projects had to be initiated: the hazard map had to be updated, taking into consideration the frequency and magnitude of potential new events and an early warning system, enabling automatic closure of railways had to be introduced. The filling up of earth dams is currently considered by the authorities in order to protect critical infrastructure (pipeline), the road and a few settlements.

Participating authorities

The Cantonal Road, Transport and Watercourse Service together with the railway company carried out works at the confluence between the torrent Durnand and the river Dranse to protect the transportation lines, buildings and infrastructure. CREALP, a research centre funded by the Canton of Valais, developed tools such as hazard mapping and emergency planning.

4.3 La Monnaie gallery: combined measures to protect against snow avalanches and rock falls

Background

On 29 November 2003, the rockslide of a section of cliff (~100 m^3) partly destroyed the La Monnaie gallery between Bovernier and Sembrancher (Figure 7). This sudden event unfortunately resulted in one casualty. Immediately, the Cantonal Road, Transport and Watercourse Service devised a system to monitor the cliff to ensure the safety of commuters and a rapid reopening of the road. Traffic was restored on 19 December 2003, before the beginning of the tourism season, with a single drivable lane in the damaged gallery.

Figure 7: Damages to the La Monnaie gallery on 29 November 2003.

Challenges and opportunities

The Great St Bernard highway is a major transit corridor between Switzerland and Italy, which is used daily by thousands of drivers. Traffic safety is therefore a major concern. This road also gives access to Verbier, a major ski resort. Due to the busy period (leading up to the Christmas break) and higher avalanche risks in the region, the road could not remain closed for too long.

Prevention and preparedness measures

Immediately after this event, the cliff was equipped with extensometers to monitor the site, ensure the safety of traffic and to prepare for measures to consolidate the cliff. This continuous monitoring of the cliff fractures did not detect any significant movement of rock mass. Moreover, the structural analysis and geomechanics of the cliff confirmed its stability. However, to ensure a high level of safety in the long run, measures to consolidate the rock mass and the installation of a rock fall protecting net were finalised in spring 2005. The La Monnaie gallery was primarily built to protect against snow avalanches, but after this accident a cost effective way to combine this function with mitigation measures for rock falls could be found. The measures that were taken have made it possible to maintain a good level of synergy in dealing with the different hazards.

Participating authorities

The Cantonal Road, Transport and Watercourse Service and the Cantonal Forests and Landscape Service together with the affected communes were involved in this project. The technical studies and reparation works were carried out by local geologists and private engineering firms.

4.4 La Douay galleries: structural avalanche protection measures along the Great St Bernard highway

Background

Snow avalanches are frequent in the valley along the Great St Bernard highway. They endanger road and railway infrastructures. The two La Douay galleries provide protection against snow avalanches. They were constructed after the Great St Bernard highway was covered by an avalanche originating in Pouta Revenna on 20 January 1981 over a length of around 200 m (Figure 8, left).

Figure 8, left: Snow deposits on the road after the avalanche of 1981. Right: The two avalanche paths (yellow arrows pointing to the two galleries).

Challenges and opportunities

The avalanche crossed the international Great St Bernard route between Sembrancher and Orsières. As it is one of only four passages through the Alps between northern and southern Europe, this transit road must be accessible for a maximum number of days per year. Figure 8, right shows the main road on the east face of Mount Catogne (2400 m alt.) and the triggering areas.

Prevention and preparedness measures

Only large avalanches with an average return period of 5 to 10 years reach the road at this location. Potential triggering areas are too large to be stabilised by racks. The forest on the mountainside has only a small protective effect by reducing the velocity and breaking the size of the snow avalanches, which made structural measures necessary to protect the road. The decision was therefore taken to lead the road into two protection galleries under the avalanche paths (Figure 8, right).

Participating authorities

The Cantonal Road, Transport and Watercourse Service and the Cantonal Forests and Landscape Service together with the municipalities concerned were involved in this project. The technical studies and construction works were carried out by private engineering firms.

4.5 Avalanche protection and monitoring measures at the north entrance to the Great St Bernard tunnel

Background

Work on construction of the Great St Bernard tunnel began in the spring of 1958 and was completed in less than six years. At each end of the tunnel there is a terminal with on-site infrastructure management services, a customs control point, and a police station. Opened on 19 March 1964, this was the first tunnel to allow road traffic through the Alps over the entire year. Today, average daily traffic is approximately 1,800 vehicles.

Challenges and opportunities

The north entrance to the Great St Bernard tunnel, in the direction of Italy, is located at around 1,900 m alt., at the end of a 5.77 km protection gallery. The surrounding mountainsides are covered with bushy vegetation that has no protection effect against avalanches.

According to the cantonal register of natural events, the main hazard to the road and the tunnel entrance is posed by avalanches. The avalanche hazard map (Figure 9) defines the degrees of hazard and serves as a basis for land and road planning. The red zone (avalanche pressure > 30 kN/m^2) indicates a high hazard, and the blue zone (pressure between 3 and 30 kN/m^2) a medium hazard.

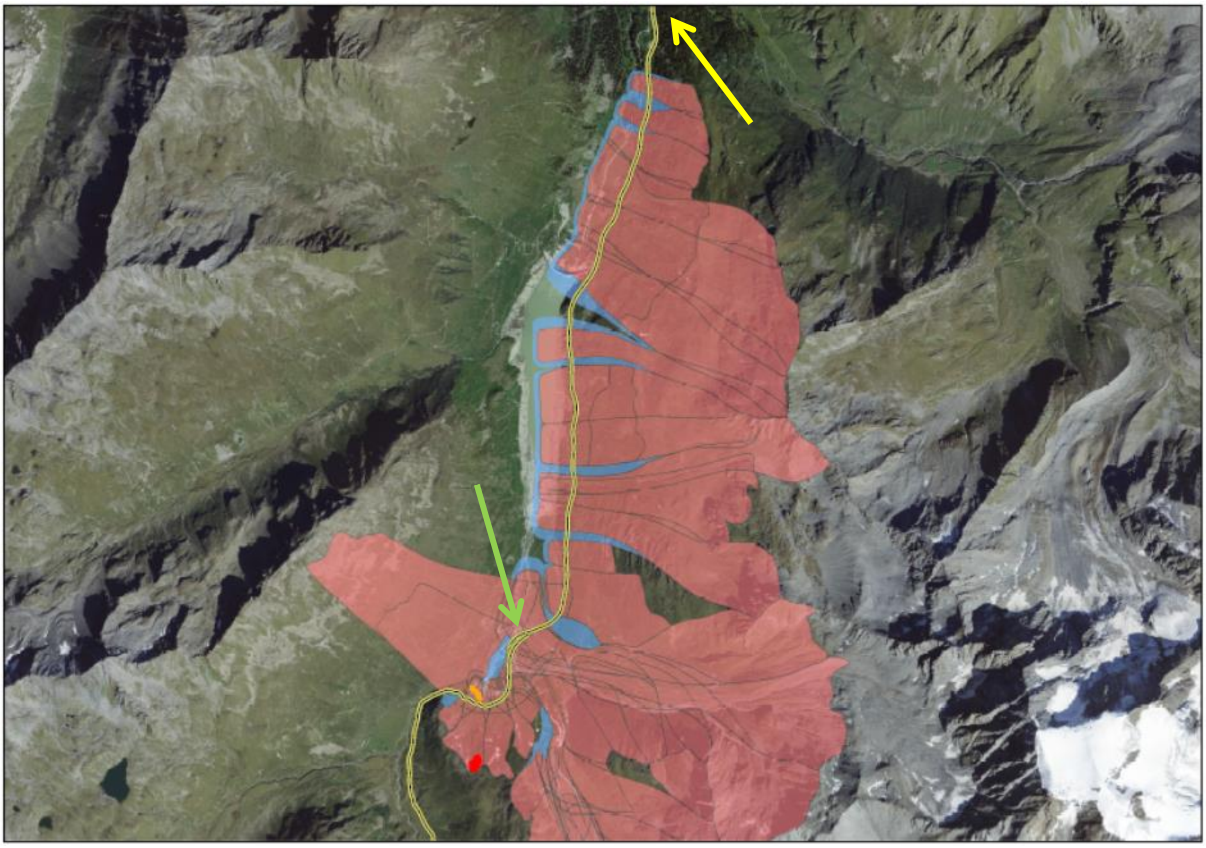


Figure 9: Map of hazards (red zone = high hazard, blue zone = medium hazard) and protective structures (red markings = metal barriers, orange markings = retaining wall) along the road (yellow line) between the village of Bourg St-Pierre (yellow arrow) and the entrance to the Great St Bernard tunnel (green arrow).

Prevention and preparedness measures

Permanent installations for structural protection against avalanches were built in 2007 taking into account the register of natural events, the hazard map, and technical studies. Metal barriers were installed uphill in an avalanche starting zone that directly threatens the entrance to the tunnel, and a retaining wall was constructed downhill, just above the entrance to the tunnel, in the avalanche runout zone (Figure 10, left and right). An avalanche gallery was also built to protect traffic between Bourg-St-Pierre (the last village before the tunnel) and the entrance to the tunnel.

Figure 10, left: Metal barriers installed in the avalanche starting zone threatening the entrance to the tunnel. Right: Retaining wall constructed in the runout zone above the entrance to the tunnel.

Participating authorities

The Cantonal Road, Transport and Watercourse Service (SRTCE) is responsible for road safety. The Cantonal Forests and Landscape Service (SFP) is responsible for managing winter risks and avalanche protection structures. The technical studies on which the construction of the protection structures was based were carried out by local civil engineering firms from the private sector.

4.6 Debris flows linked to permafrost degradation at the Perche glacier

Background

The design for the north entry gate to the Great St Bernard tunnel took into account the effects of debris flows that had been observed until that time, based on the traces that were visible at the site. The dimensions of the protection gallery were consistent with the known facts. However, due to the degradation of glaciers, more recent incidents showed increasing intensity, and the size of the protection structure was found to be no longer adequate. Indeed, on 3 September 2011, during a period of good weather, with no precipitation, a debris flow of exceptionally high volume was triggered. The dimensions of the access gallery leading to the tunnel very quickly proved to be insufficient. As debris continued to accumulate uphill from the gallery, the pressure on the non-protective walls of the gallery continued to mount. The walls, which were primarily designed to protect against avalanches, were not large enough to withstand such pressure, and ultimately gave way (Figure 11, right).

Challenges and opportunities

Located just a few dozen metres before the north entrance to the tunnel, a 5.77 km protection gallery passes through a large number of avalanche corridors. This infrastructure is essential in order to ensure the safety of road and tunnel users throughout the year. In addition to the risk of avalanches, the gallery must now also be able to stand up to new sources of hazards, such as debris flows and/or a new dynamic of dangerous natural events driven by global warming.

Prevention and preparedness measures

In 2007, the Canton of Valais began a systematic study of permafrost zones and their influence on the risk of debris flows (largely due to an event that occurred at Durnand, see Factsheet 4.2). The fact that Little Ice Age glaciers no longer have a glacial surface appearance (Figure 11, left), being now covered in rocky debris, means these types of events are still very difficult to predict. The work that had been done to protect against avalanches (the volume of which is far greater than that of debris flows) made it possible to deal with this developing hazard by constructing a retaining wall, for which only a few specifications needed to be modified.

In the present case, snow avalanches are still the principle natural event for which the protection measures are designed, but the measures that were taken have made it possible to maintain a good level of synergy in dealing with the different hazards.

Figure 11, left: Zone visible from the road, located just below the source of the hazard. Right: Protection gallery showing the section fortified with reinforced concrete (red arrow) and the masonry section that was destroyed.

Participating authorities

The work was supervised by the responsible authorities of the Canton of Valais (the Road, Transport and Watercourse Service (SRTCE) and the Forests and Landscape Service (SFP)), with the assistance of private sector engineering consultancy firms.

4.7 Joint Swiss-Italian management of the Great St Bernard tunnel

Background

The Great St Bernard Pass has played a central role in relations between northern and southern Europe since antiquity. Today, crossing the Alps along this ancient route is made possible using modern means by passing through the Great St Bernard tunnel.

Work on construction of the tunnel began in the spring of 1958. In less than six years, the Swiss and Italian contractors, who were granted the concession to build, and later operated this major piece of infrastructure, completed construction of the tunnel itself, of the north and south terminals, and of the covered mountainside approach roads at both ends. Both terminals have on-site infrastructure management services, a customs control point, and a police station. Opened on 19 March 1964, the tunnel this year celebrates its 50th anniversary. This was the first tunnel to be dug passing under the Alps, making trans-Alpine road traffic possible all year round.

Challenges and opportunities

Because it is a binational undertaking, an international convention, signed on 23 may 1958, was needed to make construction and operation of the tunnel possible. The Joint Italian-Swiss Committee, which was created at the outset, has acted as the body responsible for ensuring proper implementation of the Convention on the tunnel, in keeping with legislative developments in the two countries, particularly in the areas of transportation, customs, and taxes. On 17 June 2009, the Swiss government resolved that the European Directive 2004/54/EC on minimum safety requirements for tunnels in the trans-European road network, already in effect since 2004 for the Italian section of the tunnel, would also be applied to the Swiss section. Since that time the Joint Committee has assumed the role of sole administrative authority, within the meaning of the directive.

With traffic at a level of more than 600,000 vehicles per year, ensuring the safety of the tunnel and those who use it is a task of crucial importance. Two companies – one Italian, one Swiss – hold the operating concession for the tunnel, and have from the beginning paid scrupulous attention to maintaining and improving the tunnel's infrastructures and technical equipment in order to ensure the highest possible level of traffic safety. Because the tunnel is bidirectional, the primary safety risk is that of traffic accidents. An example of an extreme scenario would be a case in which there was a violent collision (followed by a fire) between a heavy goods vehicle carrying flammable materials and a bus filled with passengers, and this in the middle of the tunnel at a time of peak traffic.

Prevention and preparedness measures

Management of facilities and traffic at the Great St Bernard tunnel is conducted from two modern control rooms located at the two entrance portals. All information required for guiding the operations of the facilities and dealing with alarms and calls for assistance is directed to those control rooms. A powerful remote control system makes the management of facilities and traffic highly reliable.

In the event of an alarm signal from the control rooms, the specially trained emergency response teams, on call 24 hours a day, immediately go into action. These teams have at their disposal special vehicles outfitted with highly effective firefighting equipment (Figure 12, right) and the means needed for providing first aid. Precise instructions for safety and conduct under normal conditions, and in case of emergency, are distributed to drivers at the entrances to the tunnel (Figure 12, left).

At each entry terminal, on both the Swiss and Italian sides, fire engines and light vehicles specially designed for emergency response in the tunnel are on call. The response teams also have at their disposal highly specialised types of equipment for working in confined areas (special helmets, radio devices, respirators, and thermal imaging cameras).

Emergency measures and response procedures were determined on the basis of a Binational Emergency Plan, an Internal Security Plan, and security documentation (as required by the directive), which outlines, in particular, the training programmes, the operating and response procedures, as well as the minimum operating conditions.

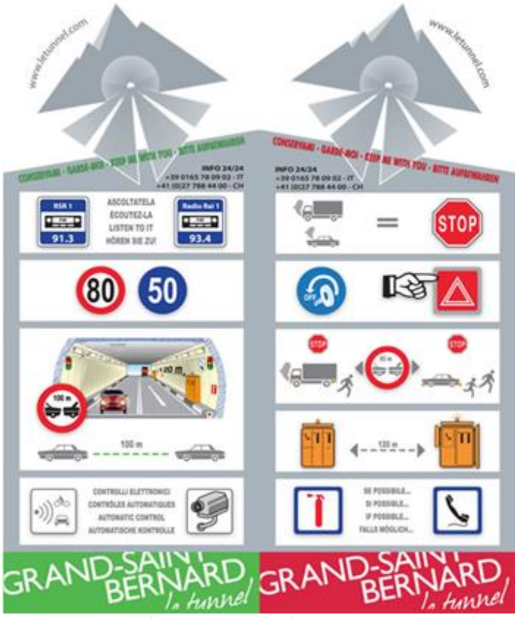


Figure 12, left: Tunnel safety instructions for automobile drivers. Right: Emergency response team, on call 24 hours a day.

Participating authorities

The two companies that hold the operating concession, "SITRASB SpA" and "Tunnel du Great St Bernard SA" are responsible, together with the Italian-Swiss company "SISEX SA", for the binational management of the tunnel (investments, maintenance, and operations). Following the entry into effect of European Directive 2004/54/EC for the whole of the tunnel, SISEX SA, under the authority of the Joint Italian-Swiss Committee, has become the sole tunnel manager.

Cooperation between Italy and Switzerland runs very smoothly, both between the companies with the operating concession and within the Italian-Swiss company SISEX SA. This is also the case with co-operation between the regional authorities (Valais/Switzerland – Aosta Valley/Italy) and those of the two countries (through the Joint Italian-Swiss Committee). This, however, does not change the fact that management of a major structure that straddles the border between Switzerland and a country belonging to the European Union remains complex, legally, administratively, and technically.

4.8 Hazards on the Aosta Valley transit route

Background

The Autonomous Region of Aosta Valley has an area of around 3,000 km², making it the smallest region of Italy. Its territory is entirely mountainous, with an average of around 2,000 m alt..

Two roads of international importance cross the region, providing access to the neighbouring countries of France and Switzerland. However, because of the altitude of the Alpine passes – 2,188 m alt. for the Little St Bernard Pass, 2,473 m alt. for the Great St Bernard Pass – there was no certainty that a crossing would be possible over either of these roads during the winter season. This difficulty was resolved by the now widely renowned Mont Blanc and Great St Bernard tunnels.

Challenges and opportunities

The character of the Aosta Valley is such that avalanches constitute a very real hazard in the region. The number of known and recorded avalanche sites on the territory of Aosta Valley Region is over 2,050, spread out in such a way that some 15% of the total land area is vulnerable to such phenomena. Even more significant are the statistics concerning avalanches that affect road conditions to various degrees.

Prevention and preparedness measures

Avalanche risk management in the Aosta Valley is accomplished, at the regional level, through the regular issuance of snow and avalanche bulletins. Continuous hazard assessments, based on the generally recognised European scale of reference, are made for each of the 21 sub-zones into which the region is divided, making it possible to obtain a highly detailed overview of the situation even at the synoptic level.

Myriads of data are analysed for assessing the degree of the hazard: meteorological data on snow conditions from more than 100 weather stations spread throughout the territory, evaluations of the stratigraphic characteristics of the snow cover, along with numerous analyses concerning the stability of the cover itself. Overall, in the course of a week, there are some 70 surveyors/operators who furnish the database with information for analysis, in addition to the data received from the automatic weather stations.

In operational terms, for purposes of civil protection, it is necessary, however, to make the transition from hazard assessment to risk assessment. At the regional level, this transition is made by issuing daily bulletins on critical avalanche situations. These bulletins also include an assessment as to the possible interference of the anticipated avalanche phenomena with the infrastructure. At the local level, these assessments are then "refined" by local avalanche committees (*Commissioni Locali Valanghe* – CLV), though at present this is still done largely on the basis of subjective "perceptions and experience". Because of this, many of the efforts that are undertaken by the region, thanks mainly to numerous interregional and cross-border projects, are aimed at making these assessments more objective by seeking to define anticipated risk scenarios.

A study of the SS 27, the national route leading to the Great St Bernard Pass, shows that there have been numerous avalanches – roughly twenty – that affected the roadway. Fortunately, however, they did not create all too many problems for international traffic, since they occurred almost entirely on the stretch of the road that is normally closed to traffic in winter – from late October or early November until the end of May or early June – due to snow. For the few avalanche sites that are of concern for the access road to the tunnel, various precautions have been taken over the years, either in the form of active intervention by installing avalanche protection structures on the slopes (Figure 13), or in a more passive form through the construction of avalanche protection galleries.

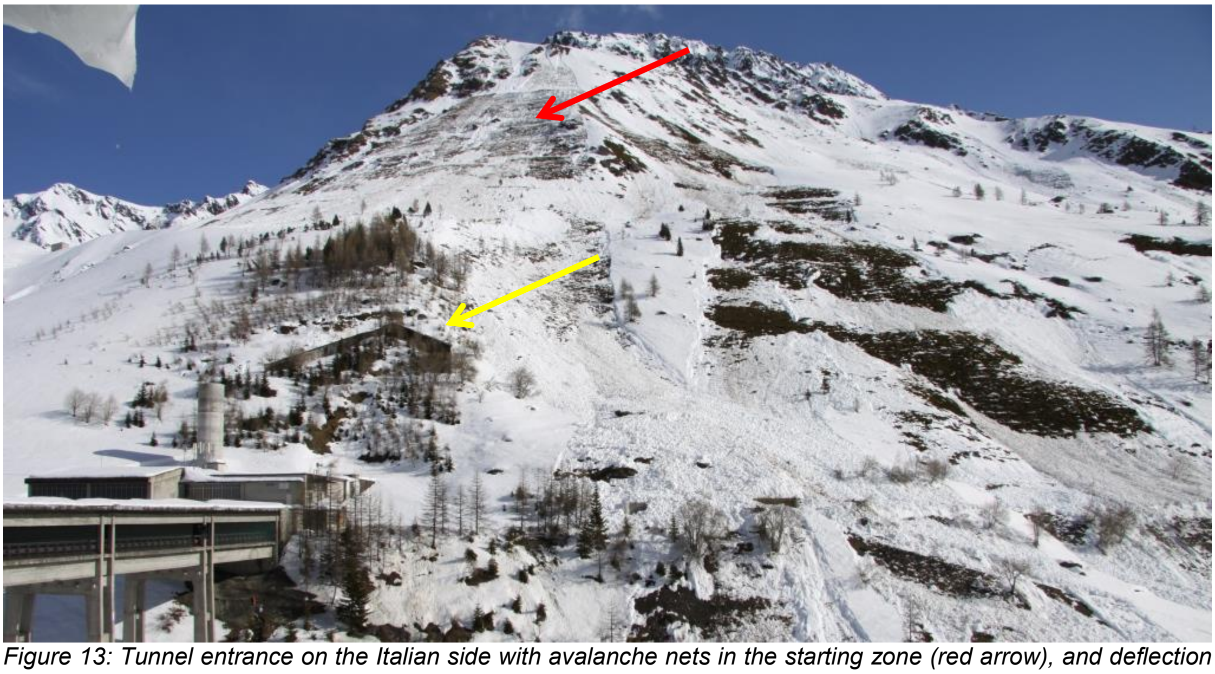


Figure 13: Tunnel entrance on the Italian side with avalanche nets in the starting zone (red arrow), and deflection wedge in the flow zone (yellow arrow).

Participating authorities

For the assessments made at the local level, the region enacted in 2010 a regional law – L.R. 29/2010 – which called for the creation of the *Commissioni Locali Valanghe* (CLV). These now serve as technical advisory bodies to assist the local mayors with the decisions they may need to make. Altogether there are 17 such CLVs, and except in a few cases, their authority extends over an area that comprises several villages at the same time. It is required that their members include mountain guides, ski area managers, and the heads of forest stations in the zone of the committee's authority, all of whom must have had special professional training in dealing with avalanches.

There are numerous interregional, cross-border projects carried out in cooperation between colleagues from Italy and Switzerland. Indeed, over the years, friendships have been established that go beyond the mutual interest of professionals in exchanging technical visits to the areas for which they are responsible.

4.9 Village of Bourg-St-Pierre: physical and biological protection measures against avalanches

Background

Bourg-St-Pierre is the last village before the entrance to the Great St Bernard tunnel. The main route, where traffic averages 1,800 vehicles per day, passes above the village on the westward slope, before entering the avalanche protection gallery that leads to the tunnel entrance. The protection forest in the transit zone plays a crucial role. It serves both to prevent the release of avalanches and as a protective barrier against rockfalls.

Challenges and opportunities

According to the register of natural events of the Canton of Valais, the main hazard threatening the village and the main route is that of avalanches. The avalanche hazard map (Figure 14) defines the degrees of hazard and serves as a basis for land zoning (zoning plan). The red zone (avalanche pressure > 30 kN/m^2) indicates a high hazard, and the blue zone (pressure between 3 and 30 kN/m^2) a medium hazard. The hazard of rockfalls, which also pose a threat - though a lesser one - to the main route and certain residential buildings in the village of Bourg-St-Pierre, has also been mapped.

Prevention and preparedness measures

On the basis of the register of natural events, the map of hazards, and technical studies, structures of adequate size for protection against avalanches were designed and constructed uphill in the release zone (metal barriers and avalanche nets). Below the forest, retaining walls were built to protect residential buildings and the road against rockfalls.

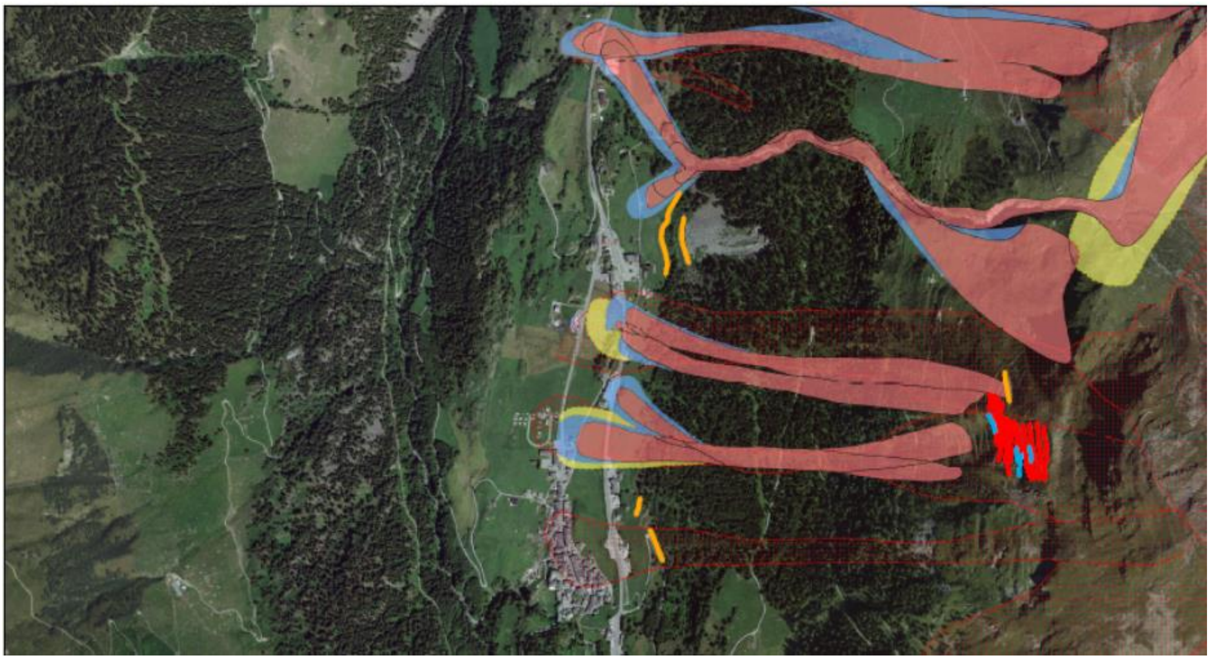


Figure 14: Hazard map (red zone = high hazard, blue zone = medium hazard, yellow zone = low hazard), with register of avalanche events (red dotted zone) and protection structures (red markings = metal barriers, blue markings = avalanche nets, orange markings = retaining wall).

The protection forest in the transit zone, located above Bourg-St-Pierre, plays a very important role; it stabilises the snow, and prevents the release of avalanches. It also serves as protection against rock-falls. These protection forests are listed in a national inventory (SilvaProtect-CH), and are managed in such a way as to ensure that they can sustainably perform their protective function (Figure 15). The silvicultural management of these forests is primarily aimed at maintaining continuous groundcover in keeping with guidelines for the sustainable management of protection forests (biological measures). The sustainable multi-functional management of these forests – so that they can fulfil not only a protective function (against avalanches and rockfalls), but also an economic function (wood production) and ecological function (biodiversity conservation) – makes it possible also, and especially, to save on construction costs for protection infrastructures, which are often quite substantial.

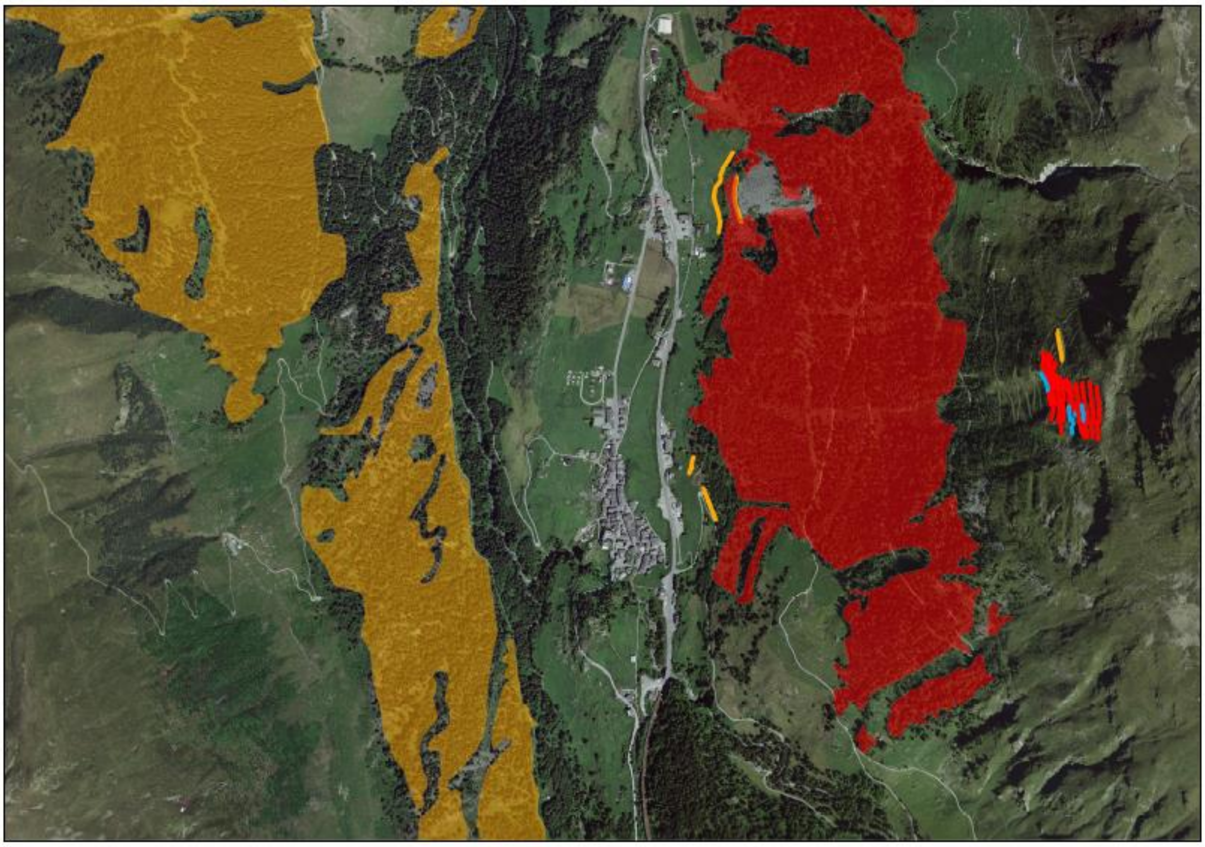


Figure 15: Map of protection forests (red zone = high priority protection forests, orange zone = medium priority protection forests) showing protection structures (red markings = metal barriers, blue markings = avalanche nets, orange markings = retaining wall).

Participating authorities

The Cantonal Road, Transport and Watercourse Service (SRTCE) is responsible for road safety. The Cantonal Forests and Landscape Service (SFP) is responsible for the management of winter risks, avalanche protection structures, and the management of protection forests. The technical studies on which the construction of the protection structures was based were carried out by local civil engineering firms from the private sector.

5 Field visit 2: Management of natural and technical risks (floodplain of the river Rhone/Monthey)

General introduction

This field visit will focus specifically on the seismic and hydrological hazards in the Rhone Valley, in and around the town of Monthey. The economic motor of the region, with a population in the tens of thousands, Monthey is also home to a chemical production site of international importance where some 2000 people are employed.

In addition to the risks of chemical or biological accidents, the Monthey industrial site is also especially vulnerable to natural hazards, including earthquakes and flooding of the Rhone and its tributaries. The possible effects of such incidents on all or a portion of an industrial installation include the triggering of a sequence of major technological disasters (NaTech), whose harmful impact would be felt both within and beyond the bounds of the site itself, and extend to people, goods, and the environment, not only in Switzerland, but also in Italy and France.

On this field visit, we will focus in detail on the measures that can be taken for monitoring, preventing, and mitigating risks connected with the flooding of mountain streams or of major rivers, such as the Rhone, and on seismic risks. We will also be paying particular attention to the major technological risks that can be engendered by earthquakes or floods of exceptional intensity at an industrial site such as that of Monthey, and consider what has been done to prepare for them.

At each station we will give a presentation showing how the integrated risk management strategy was put into effect in order to achieve implementation of various prevention and preparedness measures. We will also show how cross-border cooperation and an integrated multi-risk approach make it possible to significantly mitigate the consequences of these natural hazards.

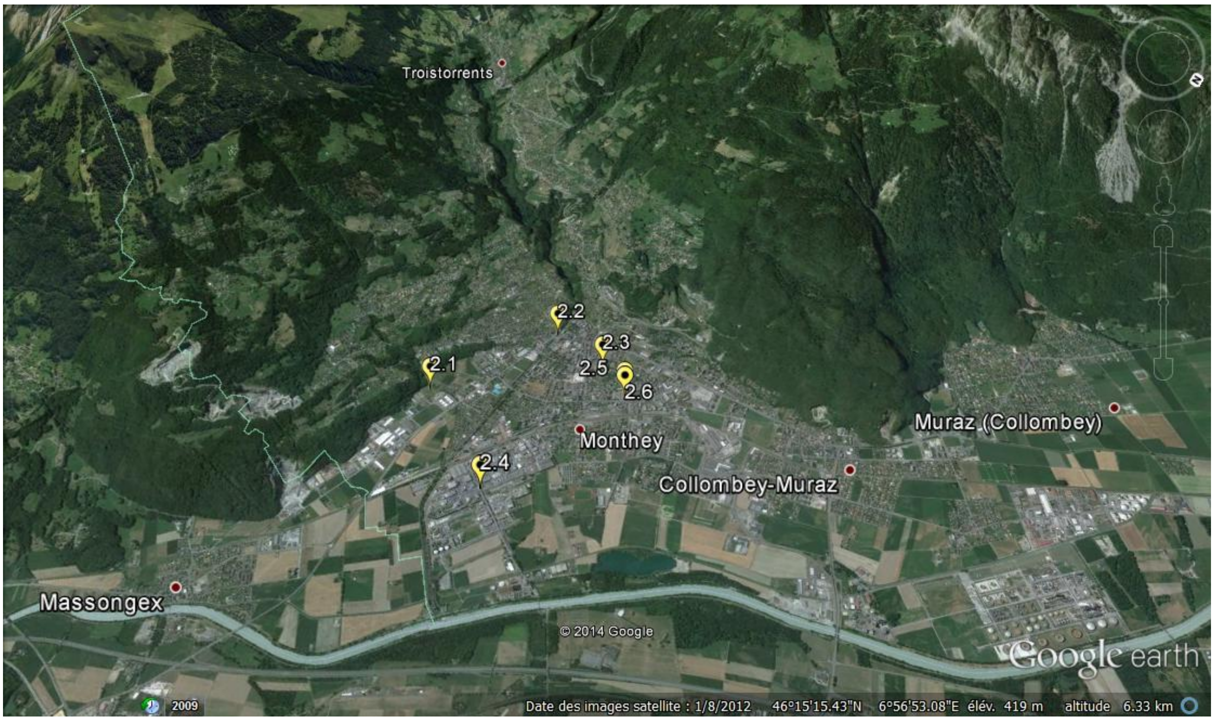


Figure 16: Map of the region around Monthey in the Rhone valley, showing the location of the various stations of the field visit (yellow marking).

5.1 Flood control of the mountain torrent Nant de Choëx

Background

The mountain torrent Nant de Choëx empties into the river Vièze, just before the latter feeds into the Rhone. The drainage basin extends over an area of 6 km² and is mostly forest but, lying at the first foothills of the Dents du Midi mountain range, it is exposed to storms that can occasionally be quite violent. Approximately every ten years, overflows occur, mainly due to flash flooding, which cause serious damage in a recently developed residential area in the town of Monthey.

Challenges and opportunities

Attempting to control flooding of the torrent Nant de Chöex by means of a flood channel capable of dealing with a one-hundred-year flood would have required construction of a watercourse of disproportionate size in the plain area. It was thus necessary to find another, more efficient method for controlling the torrent, while keeping in mind that there were many uncertainties with regard to the flood estimates. It was imperative that these uncertainties be taken into account in order to ensure that the flood control structure did not become the source of a more serious hazard than the situation created by nature. Careful planning was therefore needed to manage the residual risk of overflows from that structure.

Prevention and preparedness measures

Substantial construction was undertaken in the early 2000s in order to provide flood protection for the residential area in question, which also made possible the renaturation of the stream. Because the flooding is of short duration, it is possible to attenuate the peak flows by construction of a buffer, in this case a retention basin (Figure 17). The basin was built along the Nant de Choëx and has a volume of 35,000 m³. This makes it possible to limit the flow of water downstream to a maximum of 10.5 m³/s in the event of a one-hundred-year flood, whereas the natural flow of such a flood would be on the order of 23 m³/s.

Figure 17: Construction of the retention basin in 2003.

The construction for transferring excess flows to the basin consists of a concrete channel, approximately 25 metres in length, the downstream section of which is controlled by an orifice. The wall on the right bank is lower, so that as soon as the orifice begins to open, overflows can enter the basin flowing over a riprap (loose stone ramp). The basin is also equipped with an overflow valve for extreme floods, which makes it possible to direct any excess flows towards an area with a low damage potential, so as to reduce the residual risk on the left bank (Figures 18 and 19).

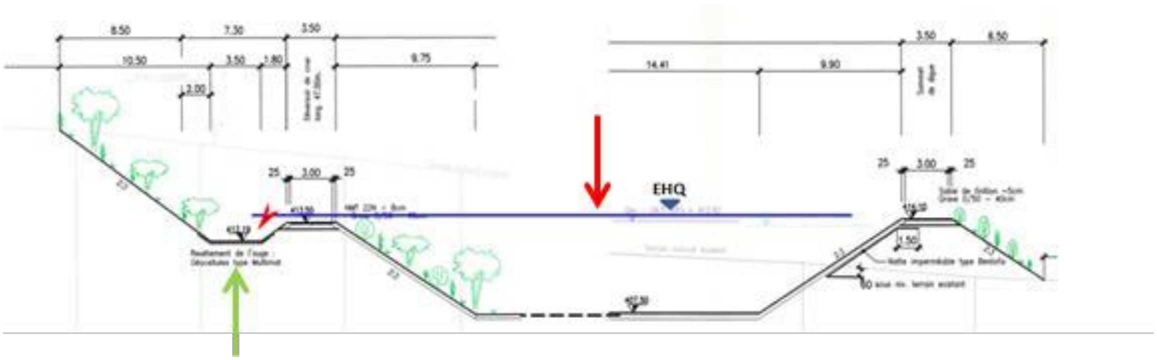


Figure 18: In the event of extreme flooding (EHQ), the overflow from the Nant de Choëx (red arrow) is emptied through a channel (green arrow) along the slope into a low sensitivity zone.

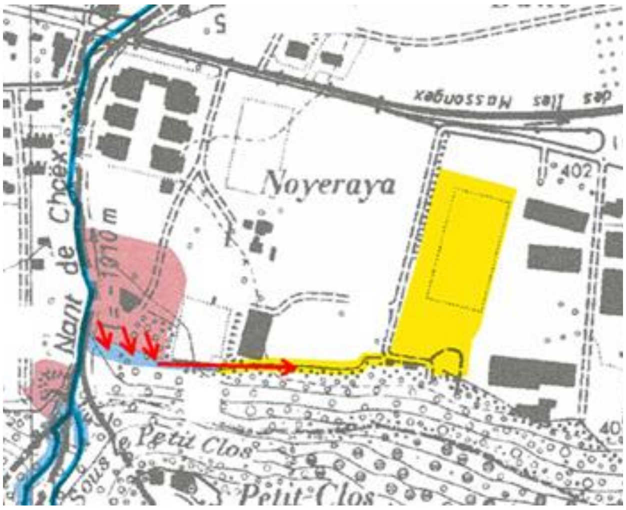


Figure 19: Residual risk management (in yellow) in a construction regulation zone.

For the residual risk zone, appropriate construction regulations are needed, so that any damage remains within reasonable limits even in the occurrence of an extreme event (no basement construction, no sensitive installations at the first floor level).

Participating authorities

Various federal agencies, including the Federal Office for the Environment (FOEN), the Cantonal Road, Transport and Watercourse Service (SRTCE), along with other authorities of the Canton of Valais and the authorities of the commune of Monthey (awarding authority) were involved in this project.

5.2 The 3rd river Rhone correction and renaturation for flood protection

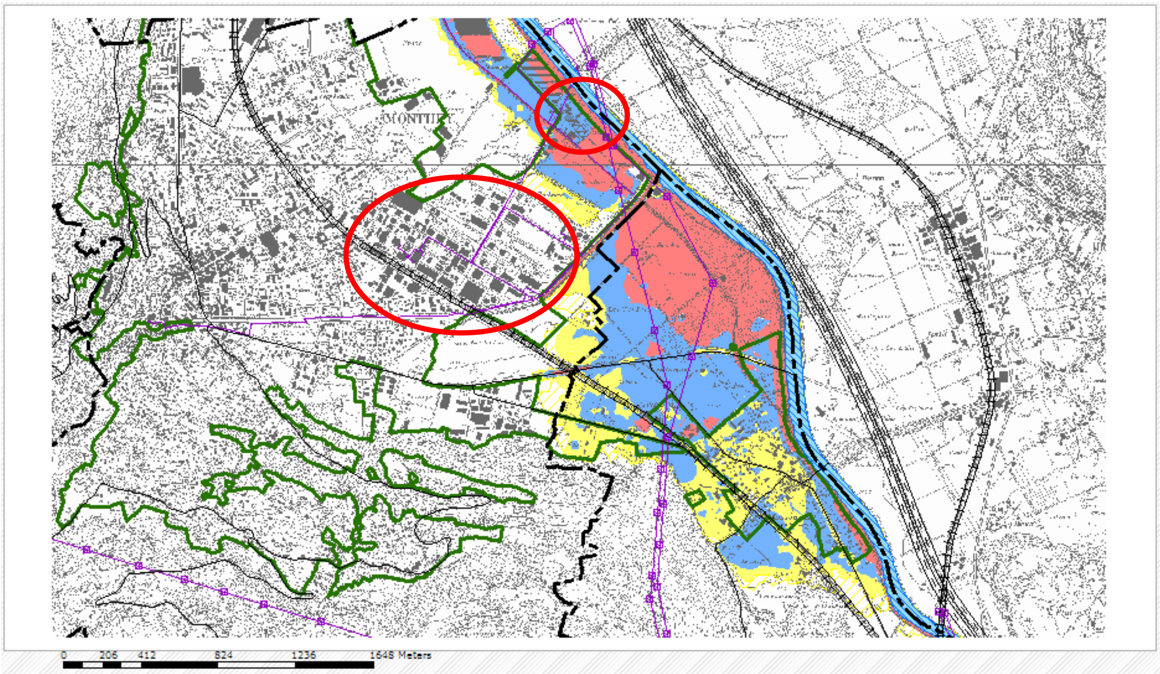
Background

Existing flood protection works cannot provide sufficient protection along the whole 170km of the river Rhone from the Rhone Glacier to Lake Geneva. Like for many other flood protection works in Switzerland, peak design flow values for the river Rhone have been revised in the last 20 years to take more serious potential damage, recent extreme flood events and statistical uncertainties into account. Hydraulic capacities designed at the beginning of the 20th century are no longer sufficient to meet contemporary safety standards, although the more frequent flood events have reduced peak flows due to alpine hydropower reservoirs.

Challenges and opportunities

Some 13,000 hectares of the Cantons of Valais and Vaud are endangered – whether owing to river dam breaches or insufficient hydraulic capacity – by static or dynamic inundation. These areas are primarily agricultural (60%), as agriculture is still the prevailing land use in the plain. Inhabited areas represent 30% of the area potentially susceptible to flooding. Total potential damages are estimated at more than CHF 10 billion. In the region of the commune of Monthey, which is an important site for chemical industries, the potential damages are very high due to the risk of natural hazard triggered disasters leading to industrial accidents (NaTech).

Hazard maps based on detailed 2D hydraulic modelling show that river dam breach scenarios lead to very high intensity in terms of flow velocity or inundation depth on more than 40% of the areas at risk (red area in Figure 20). The hazard map has implications for land use planning in Switzerland: in the red zone no additional construction is permitted, in the blue zone (medium danger) construction is only permitted under strict conditions and in the yellow zone (low danger) construction is permitted with some constraints.



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Mise à jour 18.03.2014

Figure 20: Inundation map (hazard map) of the river Rhone in the region of Monthey (red circles = chemical industrial sites, one of them close to the river Rhone).

Prevention and preparedness measures

The need for a 3rd correction of the river Rhone became obvious after the 1987 flood. The systematic planning of a design project began in 1995, but it was only in 2008 that a master plan was put to public consultation. Two independent studies were ordered and the project was approved in 2012.

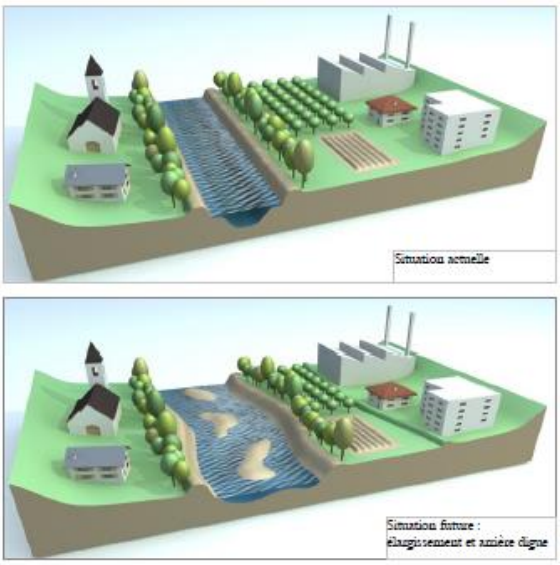

Figure 21: Current profile of the river Rhone (top) and profile after the widening of the river (bottom) (source: cantonal authorities Valais)

The flood protection concept aims to achieve various specific protection goals with the objective of protecting the flood plain against at least a 100-year flood. Densely urbanised areas or areas where potential damages are high such as the city of Monthey are protected against extreme flooding events and through the establishment of flood corridor zones in order to optimise the management of residual risks. To achieve these goals the option of widening the river was chosen. Widening the river is the best solution to reduce risk wherever sufficient space is available. A combination of river widening and channel deepening was proposed where urbanisation or infrastructures limited the possibilities to widen the river.

Participating authorities

The Federal Office for the Environment (FOEN), the Federal Office for Spatial Development (ARE), the Cantonal Road, Transport and Watercourse Service (SRTCE), the cantonal authorities of Valais and Vaud (contracting authorities), all of the communes situated in the flood plain and the population were part of this holistic approach that led to the approval of the project on 21 November 2012.

5.3 MINERVE preventive flood management and alerting system

Background

The Canton of Valais is currently working together with *Pôle GestCrues*, a unit of the Swiss Centre for Alpine Environment Research (CREALP), on the operational implementation of the MINERVE project, whose objectives are the following:

- to develop and put into production instruments for predicting floods;
- to coordinate scientific and technical activities relevant for the implementation of an effective alerting system for protection against major floods in Valais;
- to format, install, and manage the cantonal databases and data acquisition tools so as to allow decision-making authorities to manage crisis situations in an optimal fashion;
- to serve as a monitoring operator in crisis situations and furnish decision-making authorities with updated overviews of the hydrometeorological situation throughout the incident.

Challenges and opportunities

In addition to avalanches, debris flows and erosion phenomena, floods are the main hydrological hazard in Valais, so that preventive management and early warning systems are of vital importance. The MINERVE system is built on a hydrological simulation tool based on meteorological forecasts and a decision-making assistance tool.

Prevention and preparedness measures

As soon as a critical situation has been identified, the MINERVE decision-making assistance model suggests response strategies for the preventive management of hydroelectric installations. The goal is to prevent or reduce flooding on drainage basins, in accordance with predetermined objectives and taking into account the existing constraints. The decision-making assistance model has two purposes. The first is to pre-emptively release reserves from the reservoirs and to interrupt turbine and/or discharge operations during the flood peak. The second is to optimise the re-establishment of reserves after the flood, so as to avoid any losses of water. To do this, the model relies on hydrological simulations and takes into account potential damage from floods in the Rhone Valley, as well as the economic losses engendered by preventive hydroelectric facility management operations.

The use of hydroelectric facilities for flood control is a delicate operation. While the primary objective of decision-makers is to limit peak flows in the watercourses, they must nevertheless also consider the economic impact of such measures. The objective is thus to limit the economic losses connected with preventive operations when floods occur, keeping in mind that hydrometeorological forecasts are inherently uncertain, particularly with regard to levels of precipitation and flows.

The Canton of Valais is simultaneously in the process of setting up a network of water gauges which will be useful both for the MINERVE project (model calibration) and locally, for the real-time monitoring of floods. As concerns the local monitoring, the sensors are part of the emergency plans put in place by the municipalities (who bear the ultimate responsibility for safety on their territory), while the Canton is responsible for ensuring the overall coherence of the plans.

Participating authorities

The MINERVE project is the product of a collaborative effort between the Cantonal Road, Transport and Watercourse Service (SRTCE), the Alpine Environment Research Centre CREALP, the Swiss Federal Institute of Technology Lausanne (EPFL), the Federal Office for the Environment (FOEN), and MeteoSwiss.

5.4 Protection measures against major accidents at the Monthey chemical site

Background

The chemical accident that occurred in Seveso (Italy) in 1976 had the indirect effect of prompting Switzerland to include provisions for disaster prevention in the federal environmental protection law. In addition, following the fire at Schweizerhalle on 1 November 1986, the Ordinance on Protection against Major Accidents (MAO) was enacted, and entered into force on 1 April 1991. That ordinance specifies the rules for dealing with the risks linked to the presence of industrial installations that constitute a potential chemical or biological hazard.

The MAO applies to establishments exceeding specified quantities of chemical substances and preparations, special waste products, or microorganisms, and to traffic infrastructures that are used for the transport of dangerous goods (roads, railways). Owners have an obligation to take, under their own responsibility, all appropriate safety measures for mitigating the risk to which a major accident at their facilities would expose the population and the environment.

Overall, there are today 2,477 establishments in Switzerland that are subject to the Major Accidents Ordinance. Its scope of application includes companies in the chemical and metal processing industries, liquid gas storage facilities, ice skating rinks, swimming pools, water treatment installations, agrochemical warehouses, and container parks for petroleum and heating oil.

Challenges and opportunities

The chemical production site at Monthey is the economic motor of the Chablais region. It has been in operation for over 100 years and is amongst the installations in Switzerland that are subject to the MAO. There are currently four companies that share the chemical site: BASF (pigments and optical brighteners), the *Compagnie Industrielle de Monthey* CIMO (service company), Huntsman (polymers), and Syngenta (plant protection products). Some 2,000 employees work at the site.

In addition to the risks of chemical or biological accidents, the production site at Monthey is especially vulnerable to natural hazards, including earthquakes and flooding of the Rhone. Such natural hazards could potentially provoke major technological disasters (NaTech) affecting an agglomerated population of tens of thousands.

Prevention and preparedness measures at the Monthey chemical site

Companies subject to the MAO must produce a summary report listing the potential dangers at their facilities, giving the names and quantities of dangerous substances that are used, and describing the safety measures in place. The report must also include an estimate of the extent of damage that the population and the environment could suffer in the event of a major accident. If the extent of the foreseeable damage is sufficiently low in the view of the enforcement authority (the canton), it may close the procedure. Otherwise, the next required stage is the preparation of a risk study, which must provide an estimate not only of the extent of damage but also of the probability of a major accident. The owner of the establishment has also to describe the extent to which the safety measures already in place are capable of preventing or limiting the effects of such an accident. The public authorities use the study that is presented as a basis for determining whether the level of risk is acceptable or not. If that is not the case, they order further safety measures, which may go so far as to restrict or even to prohibit the company's operations.

The companies at the Monthey chemical production site have a duty to invest not only in accident prevention measures, but also in emergency response measures in the event of an accident. For each building at the site there is a complete and detailed response plan. This makes it possible for firefighters to have at their immediate disposal the information they require for a rapid and effective response in the event of an accident. Since the entry into force of the MAO in 1991, the chemical site also possesses an emergency plan to respond to a major accident.

Figure 22: CIMO firefighter emergency response training © CIMO

A corps of firefighters licensed to respond in the event of chemical accidents has also been created and training exercises are regularly carried out in order to test the effectiveness of the emergency response plan prepared in compliance with the MAO. In the most recent exercise, carried out in 2008, over 300 people and some 30 response vehicles were involved (Figure 22). Conducted every 4 to 6 years, this type of training exercise requires nearly a year of preparation, in a collaborative effort between all of the authorities – cantonal, regional, and municipal – who would be involved if a major accident were to occur. In such a case, the corps of firefighters works in close collaboration with the staffs of the municipal and cantonal authorities. Participating authorities

Participating authorities

The responsibilities that fall within the area of the Confederation are carried out by the Federal Office for the Environment (FOEN). A federal risk register, created by FOEN in 1996 and updated every four years, includes a listing of the companies subject to the MAO, also showing their geographic distribution. In the event of a major accident capable of causing serious harm beyond Switzerland's borders, the National Emergency Operations Centre (NEOC) and the Swiss Federal Office for Civil Protection (FOCP) notify the affected countries and the authorities concerned that an industrial accident has occurred. In such a case the Federal Department of Foreign Affairs (FDFA) serves as the contact point for mutual aid under the terms of the UNECE Convention on the Transboundary Effects of Industrial Accidents.

When a major accident occurs, it is the responsibility of the Cantonal Civil and Military Defence Service of the Department of Training and Safety to issue the necessary alerts and alarms. The cantonal authorities have further the essential task of keeping a register of all of the facilities covered by the MAO and to verify whether the owners are in compliance with their obligations. To perform this task, the competent authority bases itself on the summary reports and risk studies provided by the companies. The Cantonal Service for the Protection of Employees and Employment Relationships is responsible for enforcement of the application of the MAO by companies.

On-site at the Monthey chemical production facilities, the CIMO has at its disposal a corps of professional and volunteer firefighters, as well as a first aid response team, who are licensed to intervene at any time at the chemical site.

5.5 Cantonal earthquake response plan

Background

There is no other natural event than an earthquake that can trigger, in the space of only a few minutes, a disaster and situation of distress of such enormous proportions, and which demands such an extraordinary investment of resources over a period of weeks, or even months.

Managing earthquake disasters are particularly demanding as they require all available resources and intense emergency coordination. As compared with other types of disasters and emergencies situations, they are indeed far more complex and in many ways unique.

Challenges and opportunities

The Canton of Valais is one of the cantons that is most vulnerable to the destructive consequences of earthquakes in Switzerland. Among the natural hazards that threaten its territory, this is the one with the greatest potential to cause physical harm to human beings, buildings, and the infrastructure and, in consequence, also to the overall economy. The potential cost of the damage is estimated at between 3 and 5 billion francs. It has been historically demonstrated that a major earthquake in the region of Valais would cause significant damage over a radius of some 15 kilometres from the epicentre. Due to site effect (effect caused, in the case of the Rhone plain, by a V-shaped valley and the presence of construction on soft ground (alluvium), which tends to trap the wave and thus to increase the duration of the seismic shaking), it is to be expected that a major earthquake would almost certainly have destructive consequences on the Rhone plain.

Prevention and preparedness measures

Effective mitigation of seismic risk to human beings and their economic environment is best achieved by preventive measures, the keystone of which is earthquake resistant construction, obligatory in Valais since 2004 (Cantonal Construction Act). Additional measures include planning and organisational measures to increase preparedness for dealing with the post-seismic crisis.

The main thrust of the cantonal earthquake preparedness and response plan COCPITT (***Co****ncept* ***C****antonal de* ***P****réparation et d'****I****ntervention en cas de* ***T****remblement de* ***T****erre*), which was adopted in 2013, is to define and institute preparedness regulations and measures for coordinating the on-site response in the event of an earthquake, as effectively as possible, in order to secure the safety of people, buildings, and the infrastructure as rapidly as possible. Concrete implementation of COCPITT takes the form of detailed earthquake response plans in all essential areas. The earthquake response plans, or emergency plans, consist of a combination of measures and procedures:

The principal measures to be taken for establishing an earthquake response plan or emergency plans are the following:

- development of a seismic risk map for municipal buildings and infrastructure, on the basis of which the priority response areas can be designated, along with the access routes to be secured in order to reach those areas as quickly as possible;
- pre-designation of the municipal buildings to be used as shelters, and verification that they are earthquake resistant;
- training and building of teams of specialists capable of making a rapid assessment of the post-earthquake habitability of damaged buildings, etc.
- development of inventories and core databases of municipal properties and of the human and logistical resources that are currently available or that need to be procured;
- development of specific advance response plans for existing civil protection bodies, including steps for both before and after the earthquake;
- precise identification of the resources that will be needed, and of those currently lacking, so as to allow the public authorities and the organisations involved – among others, those responsible for supplying basic necessities – to make the necessary corrections and additions for dealing with an earthquake situation.

Cross-border exchanges and cooperation

Conventions on mutual aid and exchange have been signed within the framework of established relations with neighbouring countries. These conventions make it possible, should the need arise, to count on a substantial level of aid in terms both of preparedness and of response. A convention signed with Italy's national Department of Civil Protection (*Dipartimento della Protezione Civile*) provides the basis, in particular, for transalpine civil engineering assistance in the event of a major earthquake.

In view of the expertise that Valais has acquired in major-event post-earthquake management, the Swiss Centre for Alpine Environment Research CREALP will continue to pursue exchange with European countries and, in particular, with Italy's national Department of Civil Protection, within the framework of the RiskNET project. The specific objectives of that project are the following:

- to enhance and develop the cross-border network of actors involved in the management of natural risks;
- to develop and disseminate information service tools to ensure the usability of the network and increase public awareness of it;
- to conduct training and exchange programmes in the field of natural risks, designed for various categories of users, including future post-earthquake response specialists;
- to strengthen the awareness and involvement of the general population in order to promote a more balanced understanding of risk in the public;
- to develop an approach focused on the sustainability of natural risk prevention policies.

Participating authorities

The cantonal authorities play an advisory role, and provide technical support and assistance to the municipalities. They are also responsible for verifying prevention measures, in particular compliance with seismic construction standards for new buildings and in the remediation of existing structures. The cantonal emergency coordination authority is responsible, over the medium term, for ensuring that trained specialists are on hand to be mobilised for the post-seismic assessment of the habitability of buildings.

The Cantonal Risk Observatory is responsible for monitoring and updating risk analyses. The Cantonal Office for Civil Protection, for its part, has the task of assisting the municipalities in the preparation of their response plans and of validating those plans.

The municipal emergency coordination authorities must be prepared for a specific response in the event of an earthquake. This involves emergency response forces for firefighting, civil protection, police duties, and technical and administrative services.

The Confederation established in 2004 an Earthquake Response Plan for Switzerland. That plan consists of a planning component, comprising a Response Plan and a Response Organisation Plan, and an implementation component, which foresees different scenarios for assistance measures in the event of a disaster – for communications, for transport, for supplies, etc.

The staffs of the firefighting services and the civil protection services collaborate and are mutually kept informed. In the event of an earthquake, all technical and medical rescue and civil engineering facilities are needed instantly and simultaneously throughout the entire territory. The canton has at its disposal the human resources needed for providing guidance, supervision and assistance with the coordination of operations. The Swiss army and humanitarian aid services can be mobilised on short notice in the event of a disaster in order to relieve local emergency response teams.

5.6 Seismic retrofitting of a primary school in Monthey

Background

The town of Monthey, like all of the Canton of Valais, is located in the highest seismic zone of Switzerland. Switzerland itself is a zone of low to moderate seismicity. In the Valais it is expected that a magnitude 6 earthquake should happen approximately every 100 years. A specific building code for the seismic verification of existing buildings exists in Switzerland since 2004.

Challenges and opportunities

The buildings of the municipal school complex, the *Collège de l'Europe*, accommodate some 400 students and was built before seismic building codes existed in Switzerland. The main building has a serious flaw regarding its seismic conceptual design. It would be probably seriously damaged already by weak earthquakes and would be prone to collapse by strong earthquakes. The main flaw lies in the fact that there is a very flexible ground floor, stabilised only by small columns (soft story). In view of this fact, and given the number of students regularly present in the buildings, the commune of Monthey decided to proceed with the seismic retrofitting of the entire school complex, between 2011 and 2012.

Prevention and preparedness measures

Due to the presence of the town and sensitive industrial activities (chemicals, hydrocarbons), a seismic microzonation map was prepared, which assessed the seismic action that needs to be taken into account for the seismic design or the assessment of structures. Based on the assessment of the school complex, the three classroom buildings were retrofitted using two large cores in reinforced concrete inserted between the main building and the two pavilions. (Figure 23, left). A dynamic behaviour analysis showed that the two new cores were capable, by themselves, of providing the lateral rigidity that was lacking, but this was not yet sufficient, since significant torsion effects still remained. Because of this, it was also necessary to install bracings at the corners of the main building and at the back of the two pavilions (Figure 23, left and right).

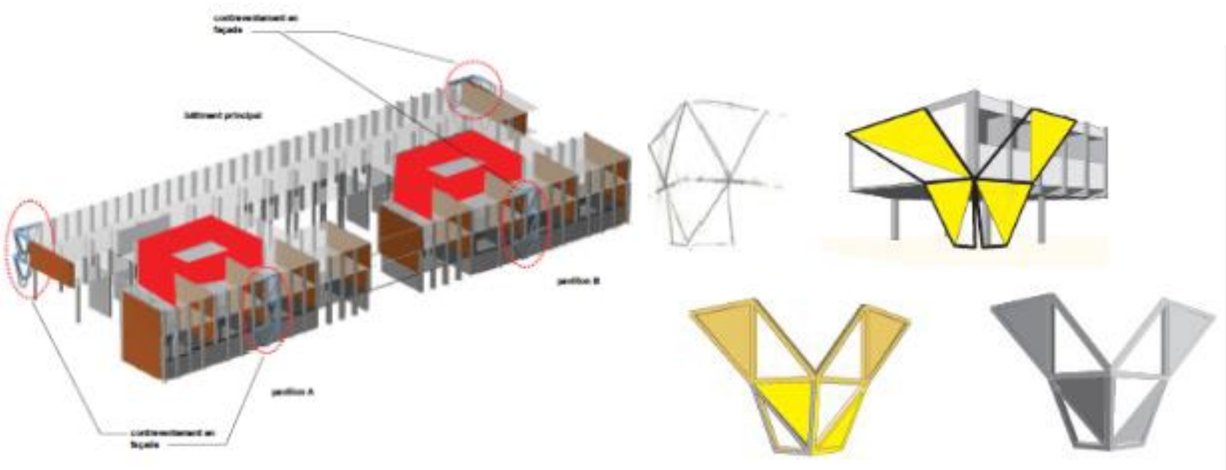

Figure 23, left: 3-D view of the school building, showing the two new cores (in red) and the bracings (circled in red). Right: Schematic representation of the bracings.

Participating authorities

The municipal authorities of Monthey hired a specialized civil engineering firm to conduct the required studies and to supervise the retrofitting, in collaboration with an architectural firm.

6 Annex

Acronyms

ARE	Federal Office for Spacial Development
CIMO	*Compagnie industrielle de Monthey SA* (service company)
CLV	*Commissioni Locali Valanghe* – local avalanche committees
COCPITT	*Concept Cantonal de Préparation et d'Intervention en cas de Tremblement de Terre* (Cantonal earthquake preparedness and response plan)
CREALP	*Centre de Recherche sur l'Environnement Alpin* (Swiss Centre for Alpine Environment Research)
DNPC	*Dipartimento della Protezione Civile (*Department of Civil Protection – Italy)
DRM	Disaster risk management
DRR	Disaster risk reduction
DRR/M	Disaster risk reduction/management
EHQ	*Extremes Hochwasserereignis* - Extreme flood
EPFL	*École polytechnique fédérale de Lausanne* EPFL (Swiss Federal Institute of Technology Lausanne)
FDFA	Federal Department for Foreign Affairs
FOCP	Swiss Federal Office for Civil Protection
FOEN	Federal Office for the Environment
GPDRR	Global Platform on Disaster Risk Reduction
MAO	Ordinance of 27 February 1991 on Protection against Major Accidents, Major Accidents Ordinance
NaTech	Natural Hazard Triggering a Technological Disaster
NEOC	National Emergency Operations Centre
SFP	*Service des forêts et du paysage* (Forests and Landscape Service) – Canton of Valais
SPT	*Service de la protection des travailleurs* (Cantonal Service for the Protection of Employees) – Canton of Valais
SRTCE	*Service cantonal des routes, transports et cours d'eau* (Cantonal Road, Transport and Watercourse Service) – Canton of Valais
SSCM	*Service de la sécurité civile et militaire* (Service for Civil and Military Safety) – Canton of Valais
UNECE	United Nations Economic Commission for Europe

Glossary

(Source: UN/ISDR, 2004)

Acceptable risk

The level of loss a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions. In engineering terms, acceptable risk is also used to assess structural and non-structural measures undertaken to reduce possible damage at a level which does not harm people and property, according to codes or „accepted practice“ based, among other issues, on a known probability of hazard.

Climate change

The climate of a place or region is changed if over an extended period (typically decades or longer) there is a statistically significant change in measurements of either the mean state or variability of the climate for that place or region. *Changes in climate may be due to natural processes or to persistent anthropogenic changes in atmosphere or in land use. Note that the definition of climate change used in the United Nations Framework Convention on Climate Change is more restricted, as it includes only those changes which are attributable directly or indirectly to human activity.*

Coping capacity

The means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster. *In general, this involves managing resources, both in normal times as well as during crises or adverse conditions. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and human-induced hazards.*

Disaster

A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources. *A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk.*

Disaster risk reduction (disaster reduction)

The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development. The disaster risk reduction framework is composed of the following fields of action, as described in ISDR‘s publication 2002 „Living with Risk: a global review of disaster reduction initiatives“, page 23:

- Risk awareness and assessment including hazard analysis and vulnerability/capacity analysis;
- Knowledge development including education, training, research and information; Public commitment and institutional frameworks, including organisational, policy, legislation and community action;
- Application of measures including environmental management, land-use and urban planning, protection of critical facilities, application of science and technology, partnership and networking, and financial instruments;
- Early warning systems including forecasting, dissemination of warnings, preparedness measures and reaction capacities.

Emergency management

The organization and management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation. Emergency management involves plans, structures and arrangements established to engage the normal endeavours of government, voluntary and private agencies in a comprehensive and coordinated way to respond to the whole spectrum of emergency needs. This is also known as disaster management.

Hazard

A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability.

Mitigation

Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.

Preparedness

Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.

Prevention

Activities to provide outright avoidance of the adverse impact of hazards and means to minimize related environmental, technological and biological disasters. Depending on social and technical feasibility and cost/benefit considerations, investing in preventive measures is justified in areas frequently affected by disasters. In the context of public awareness and education, related to disaster risk reduction changing attitudes and behaviour contribute to promoting a „culture of prevention".

Public awareness

The processes of informing the general population, increasing levels of consciousness about risks and how people can act to reduce their exposure to hazards. This is particularly important for public officials in fulfilling their responsibilities to save lives and property in the event of a disaster. Public awareness activities foster changes in behaviour leading towards a culture of risk reduction. This involves public information, dissemination, education, radio or television broadcasts, use of printed media, as well as, the establishment of information centres and networks and community and participation actions.

Recovery

Decisions and actions taken after a disaster with a view to restoring or improving the predisaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk. Recovery (rehabilitation and reconstruction) affords an opportunity to develop and apply disaster risk reduction measures.

Relief / response

The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term, or protracted duration.

Resilience / resilient

The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.

Risk

The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions. Conventionally risk is expressed by the notation Risk = Hazards x Vulnerability. Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability. Beyond expressing a possibility of physical harm, it is crucial to recognize that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes.

Risk assessment / analysis

A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend. The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios.

Structural / non-structural measures

Structural measures refer to any physical construction to reduce or avoid possible impacts of hazards, which include engineering measures and construction of hazard-resistant and protective structures and infrastructure. Non-structural measures refer to policies, awareness, knowledge development, public commitment, and methods and operating practices, including participatory mechanisms and the provision of information, which can reduce risk and related impacts.

Vulnerability

The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards. For positive factors, which increase the ability of people to cope with hazards, see definition of capacity.

Useful links

Cantonal administration

- Cantonal Service of Forests and Landscape (SFP):
  http://www.vs.ch/Navig/navig.asp?MenuID=16797&Language=fr (French)
- Cantonal Service of Roads, Transport and Watercourse (SRTCE):
  http://www.vs.ch/Navig/navig.asp?MenuID=23706 (French)
- Cantonal Service for the Protection of Employees (SPT):
  http://www.vs.ch/navig/navig.asp?MenuID=5485&RefMenuID=0&RefServiceID=0 (French)
- Cantonal Service for Civil and Military Safety (SSCM):
  http://www.vs.ch/Navig/navig.asp?MenuID=14109&Language=fr (French)
- Cantonal Service of Roads, Transport and Watercourse (SRTCE): The Lavanchy gallery (Factsheet 4.1)
  http://www.vs.ch/Public/doc_detail.asp?ndocumentid=13186&sLangID=fr&sCodeID=CONT&nColor=10&ServiceID=30 (French)

Federal administration

- Federal Office for the Environment (FOEN):
  http://www.bafu.admin.ch/
- Federal Office for the Environment (FOEN), topic flood protection:
  http://www.bafu.admin.ch/naturgefahren/01916/index.html?lang=de (German/French)
- Federal Office for the Environment (FOEN), topic prevention of major accidents:
  http://www.bafu.admin.ch/stoerfallvorsorge/index.html?lang=fr (German/French)
- Federal Office of Meteorology and Climatology (MeteoSwiss):
  http://www.meteosuisse.admin.ch/web/en.html
- Federal Office for Spatial Development (ARE):
  http://www.are.admin.ch/themen/raumplanung/00244/00432/ (German)

- Federal Office for Civil Protection (FOCP): http://www.bevoelkerungsschutz.admin.ch/internet/bs/en/home/das_babs.html
- Federal Department of Foreign Affairs (FDFA): http://www.eda.admin.ch/eda/en/home.html

Projects and studies

Listed in order of appearance:

- Study on permafrost developed by the Canton of Valais: www.crealp.ch/permafrost (French)
- Technical expertise (Factsheet 4.2): http://www.fxmarquis.ch/pag-dangers-hydrologiques (French)
- *Tunnel du Great St Bernard et Commission mixte italo-suisse* (Factsheet 4.7): http://www.letunnel.com/homepage.asp?l=3
- Snow and avalanche Bulletin (Factsheet 4.8): http://appweb.regione.vda.it/DBWeb/bollnivometeo/bollnivometeo.nsf/vista_i/$first?OpenDocument&L=_i
- Snow and weather reports (Factsheet 4.8): http://appweb.regione.vda.it/DBWeb/bollnivometeo/bollnivometeo.nsf/Rendiconto?OpenForm&L=_i&
- Avalanche register (Factsheet 4.8): http://catastovalanghe.partout.it/ (Italian)
- Risknet - Risknat project (Factsheet 4.8, 5.5): http://www.risknet-alcotra.org/fr/ (French/Italian)
- Strada project (Factsheet 4.8): http://www.progettostrada.net/ (Italian)
- SilvaProtect-CH programme of the Federal Office for the Environment (FOEN) for the sustainable management of protection forests (Factsheet 4.9): http://www.bafu.admin.ch/naturgefahren/01920/01964/index.html?lang=fr (French)
- Civil engineers, ESM-group (Factsheet 5.1): http://www.esm-group.ch/ref/PDF/h.Choex2.pdf (French)
- Flood prevention / project MINERVE (Factsheet 5.3): http://www.crealp.ch/en/accueil/thematiques/dangers-naturels/crues.html (French)
- *Compagnie Industrielle de Monthey SA* (CIMO) (Factsheet 5.4): http://www.cimo.ch/accueil (French)
- Swiss Seismological Service (SED) (Factsheet 5.5): http://www.seismo.ethz.ch/index_FR
- Swiss Centre for Alpine Environment Research (CREALP) (Factsheet 5.6): http://www.crealp.ch/fr/accueil/thematiques/dangers-naturels/seismes/risque-sismique-en-valais.html (French)
- Kurmann & Cretton SA, civil engineers (Factsheet 5.6): http://kurmann-cretton.ch/index.php?contenu=ref&secteur=parasismique&dep=renforcement&ref=1138 (French)

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