2/2015

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Natural resources in Switzerland

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Living with Natural Hazards

Dossier: Lessons from the floods of 2005 > There's a limit to what flood protective structures can do > Avoiding hazard zones > Knowledge creates safety > There will definitely be another earthquake

Together for Safety

Safety is a fundamental human need. Although we are all aware that there is no such thing as absolute safety, it is important that we eliminate hazards from our everyday lives to the greatest possible extent. The prosperity enjoyed by the Swiss population is also due to the significant progress achieved in providing safety against natural hazards through the joint efforts of various federal authorities, the cantons, communes and individuals.

Floods, avalanches, rockfall and landslides will always happen in our country. What's more, it is only a question of time until a severe earthquake happens in Switzerland again. Since the floods of 1987 at the latest, it has been clear to us that technical measures alone cannot provide sufficient protection against the damage caused by natural hazards. Therefore, the paradigm change from pure hazard prevention to integrated risk management was already introduced years ago. Organisational and planning measures for risk mitigation have gained in significance since then. For example, considerable improvements have been made in the area of natural hazard forecasting and alerting.

These efforts have already yielded benefits on a number of occasions. However, such successes present another problem: we are all too willing to believe that we are finally safe. In many cases, we realise that we have advanced too far into hazardous areas when it is already too late. Even a wealthy country like Switzerland can never fully control the forces of nature. Instead of spending more and more resources on trying to fight the hazards, we do well to simply avoid them.

The protection against natural hazards will continue to create many new challenges and consume a lot of resources in the years and decades to come. Climate change with its unpredictable consequences for natural processes is not the only factor at work here. Hazard potential is increasing rapidly with settlement development. Forward-looking spatial planning and hazard-resistant construction alone can prevent the risks from increasing at the same rapid pace and the associated damage from becoming unacceptable.

Integrated risk management is a joint task that involves the commitment of all parties — from the federal authorities, cantons and communes to the research institutes, construction sector, insurance companies and each and every individual. "Together for safety" when dealing with natural hazards; this is clearly a valid formula.

Josef Hess, Vice Director FOEN

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Cover photo:

Hagneck canal in the canton of Bern where a flood protection project combined with the ecological upgrading of the canal is being carried out.

Photo: Herbert Böhler, Ex-press/FOEN

Switzerland at a Glance

The hazard situation in the Alpine country of Switzerland is influenced by the significant differences in altitude over a small area and relatively high precipitation volumes as compared with the rest of Western Europe. Floods, in particular, can arise almost everywhere as water run-off per square meter is almost four times the global mean. *Text: Beat Jordi*

Switzerland lies in the temperate climate zone of the centre of Western Europe and borders on France, Germany, Austria, Liechtenstein and Italy. Its territory totals 41,285 square kilometres (km^2), of which almost two thirds are located in the Alpine region. The intensively developed residential and economic zone is concentrated on the relatively flat Central Plateau which only accounts for 23 percent of the country's territory. Nestled between the Jura mountains in the north west and the foothills of the Alps in the south, this plain, which ranges from 50 to 100 kilometres in width, extends in a north-east direction from Lake Geneva to Lake Constance.

Densely populated Central Plateau

The vast majority of Switzerland's population of around 8.2 million people live in the lowland. In addition to the centres of industrial production, the majority of the important service operations and the main road, rail and aviation infrastructure, all of the major cities, i.e. Geneva, Lausanne, Bern, Lucerne, Zurich and Basle, are located there. Thus, with a population density of more than 600 people per km^2, the Swiss Central Plateau is one of the most densely populated areas in Europe.

High levels of run-off

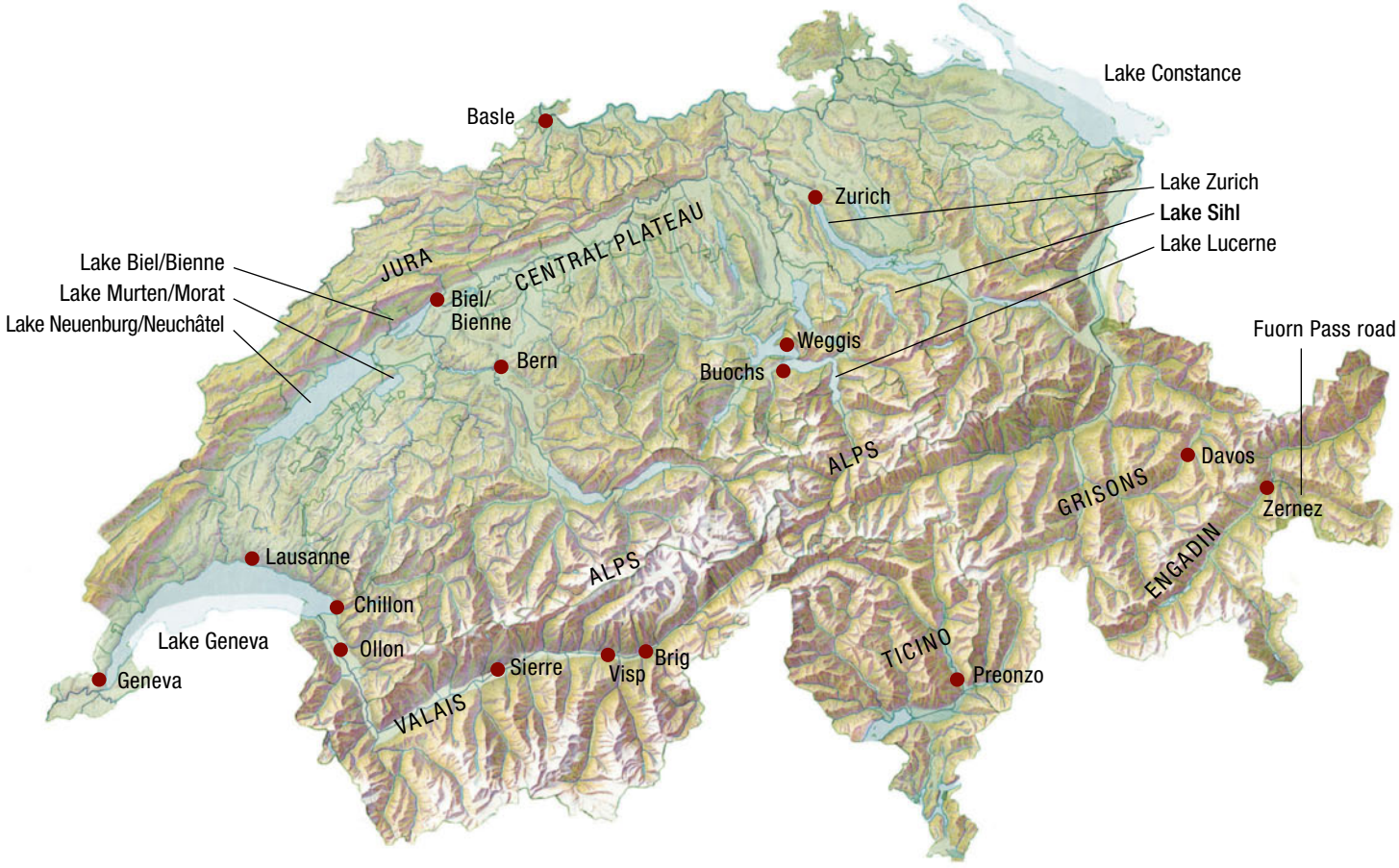
Due to the prevailing westerly winds and the country's proximity to the Atlantic Ocean, the Mediterranean Sea and the North Sea, a lot of humid air is blown towards the Alps. Rain fronts often accumulate for days in front of this meteorological barrier, giving Switzerland above-average annual precipitation volumes of around 1,460 litres per square metre (m^2). A good two thirds of this, i.e. almost 1,000 litres per m^2, is discharged to other countries through an intricate network of streams and rivers. The mean water run-off in Switzerland is almost four times higher than that in the rest of Europe and the world. Thus, a total of 40 billion cubic metres of water flow into the Mediterranean, the North Sea and the Black Sea via the main rivers, i.e. the Rhine, the Rhone, the Ticino (via the Po) and the Inn (via the Danube). This explains Switzerland's crucial role as a water reservoir for Western Europe.

Almost countrywide flood risk

Due to the extensive network of water courses, whose combined length totals around 65,000 kilometres, and due to the extreme differences in altitude of up to 4,000 metres over a relatively small area between the Alps and the Central Plateau, floods can occur almost everywhere in Switzerland. Moreover, the steepness of the terrain exacerbates erosion and hence, also, the risks posed by landslides and debris flows. Warmer periods, when the seasonal snow and glacier melt in the Alpine region coincide with intensive storms or orographic precipitation, are particularly critical. In this situation, rivers and lakes often break their banks and flood the valley plains.

Wide range of hazards in the mountains

However, the mountain regions are significantly more vulnerable to natural hazards than the Central Plateau. Heavy snowfall and unfavourably structured snow cover create a risk of avalanches at high altitudes, while heavy rainfall during the warmer seasons can trigger landslides and debris flows. Rockfall and landslides can also put both settlements and important transport routes at risk, as demonstrated, for example, by the blocking of the Gotthard motorway, a key cross-Alpine road axis between northern and southern Europe, in 2006. The above-average climate warming in the Alpine region and the resulting thawing of the permafrost and retreat of the glaciers will cause greater volumes of loose material to be mobilized in the future, a development which represents



an additional threat to settlements, transport routes and other infrastructures. Longer periods of drought also increase the risk of forest fires, particularly in the south of Switzerland. Overall, climate change is expected to increase the intensity of precipitation and storms, prompting the need for more measures to limit the extent of the damage caused by floods, hail and severe storms. Earthquakes tend to be a rare occurrence in Switzerland, however when they arise they represent the natural hazard with the greatest potential for damage.

Safety as a public service

The protection of the population and important assets against natural hazards is provided as a public service by the state. In the federal state of Switzerland, this task is perceived as the joint task of the Confederation, cantons and municipalities. The authorities on all three levels work closely with each other in this area, which requires close cooperation. Thus, for example, the 26 cantons are responsible for the maintenance of the protection forests and water bodies, hazard mapping and the planning, construction and maintenance of protective structures — however they receive financial and expert support from the federal authorities. The Federal Office for the Environment (FOEN) is responsible for the strategic management of these tasks and guarantees safety at the national level on the basis of uniform standards. It is up to the 26 cantons to decide whether to organise these tasks centrally or to delegate some of them to the political municipalities, of which there are 2,324 (status: 1.1.2015) in Switzerland. Thus, the system accommodates the cultures of political cohabitation which vary from region to region.

Hans Peter Willi

Hans Peter Willi is a hydraulic engineer. Following his studies at the ETH Zurich, he initially worked in the private sector. In 1982 he became a project manager at the Office for Water Protection and Hydraulic Engineering of the Canton of Zurich. He then held the position of Director of the Water Risks Section of the Federal Office for Water and Geology (BWG) for 18 years. He has been head of the Hazard Prevention Division at the FOEN since 2006.

Photo: Christine Baerlocher, Ex-press/FOEN

10 YEARS AFTER 2005

"We have made major gains in terms of safety"

Around ten years ago, torrential rain fell over the Alpine region. Torrents and lakes breached their banks and entire mountain slopes slid. It was by far the most expensive storm of the last 100 years. Would we be better equipped to deal with such an event today? *environment* asked Hans Peter Willi, head of the Hazard Prevention Division at the FOEN, this very question. *Interview: Hansjakob Baumgartner*

***environment:* Mr Willi, the storm of August 2005 claimed six lives in Switzerland and the damage caused totalled around 2.9 billion euro. What are the insights that emerged from the event analysis that was subsequently carried out?**

Hans Peter Willi: It confirmed what we had already learned from the floods of 1987: extreme weather events that exceed the capacity of our protective structures will always happen. The hazard statistics show that most of the damage arising from natural hazards is caused by events like this which exceed the overload capacity of the hazard protection structures. To manage such events, we need the integrated risk management of natural hazards, which incorporates all action options in addition to structural measures. These options have not been availed of sufficiently up to now for the simple reason that the necessary hazard information and organisational structures were lacking.

"Extreme weather events that exceed the capacity of our protective structures will always happen."

What kind of action options are available to us?

We can improve our emergency planning. Major progress has been made in this area in recent years. In some cantons every commune has its own emergency plan that builds on the hazard maps. Together with the cantons, the federal authorities provide support for the training of local natural hazard consultants. They can correctly assess the local hazard situation and support management and emergency staff with their knowledge in the case of a hazard event.

With regard to existing buildings, owners can invest in protective measures, adapt the way they use their buildings or even give them up if the risks are too high. With new buildings, construction in areas at risk from natural hazards should be avoided or should be carried out in such a way that unacceptable risks do not arise. We can also ensure that the flow of water is controlled if overload capacity is exceeded.

How is that done?

During extreme flood events, areas in which the flowing water and bedload would cause least damage are flooded using integrated safety relief valves. On the river Engelberger Aa, the airfield, sport fields and lake bathing area form a flood relief corridor before the river enters Lake Lucerne. This mechanism worked very well in 2005 and the inhabited area of Buochs was protected from the flood.

Reliable hazard information is essential for all of this, however. In this regard too, we have made great progress today as compared with 2005.

To what extent?

Hazard maps for floods, avalanches, rockfall and landslides are now available for almost all built-

up areas in Switzerland. So we are much better informed about what can happen where.

The event analysis report of 2005 also states that: "Far from all of those affected by the floods were sufficiently informed to be able to act in good time under their own initiative and within the scope of the possible measures." Would this be different today?
Yes, efforts have been made since then to improve warning and alerting – for both the emergency services and the population. A large number of actors co-operated intensively on this with the FOEN: Federal Office for Meteorology and Climatology MeteoSwiss, the Federal Office for Civil Protection's (FOCP) National Emergency Operations Centre (NEOC), the Swiss Federal Institute for Forest Snow and Landscape Research (WSL) and its affiliated Institute for Snow and Avalanche Research (SLF), and the Swiss Seismological Service (SED). Thanks to the considerable efforts on the part of all stakeholders, we are far more quickly informed than we were ten years ago.

For example, experts on all levels have online access to weather and precipitation forecasts and all measurement stations through the Common Information Platform for Natural Hazards (GIN). Thanks to the website www.naturgefahren.ch, the public can also obtain information about current hazard situations at all times.

We are well on the way. However, we must ensure that the financial resources required for these structures and services are also available in the future.

Integrated risk management

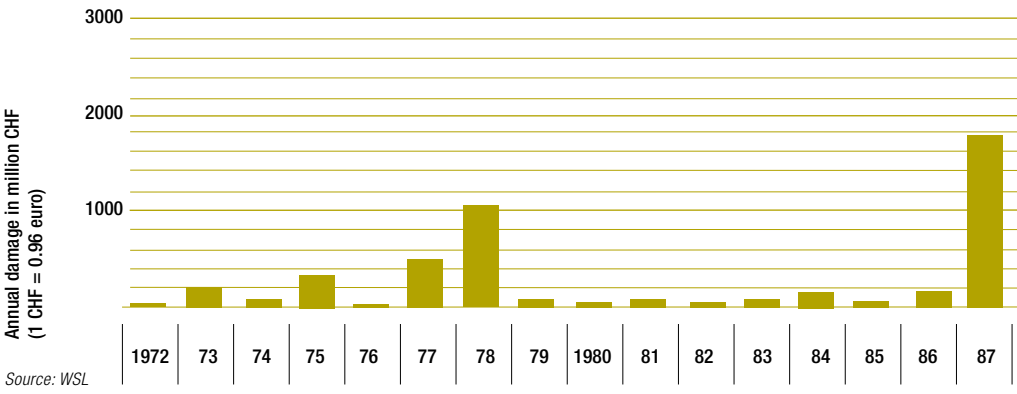
hjb. *Integrated risk management takes all natural hazards into account, involves all actors and includes all three dimensions of sustainability – ecology, economy, society. It combines measures for preparedness for natural hazard events, the response to them and recovery from them. Comprehensive hazard and risk information and documentation is at the heart of this process.*

The targeted level of safety is the product of an ongoing risk dialogue with all stakeholders. Difficult questions must not be excluded from this process: What level of safety can be attained at what price? What level of residual risk must be accepted? How much are we willing to invest to avoid a fatality within a certain period of time?

Extreme weather events had to be managed again in 2014. What did the rainy summer that year teach us?
It simply showed that storms are part of nature. Nature has its sunny and dark sides and we have to live with them. During the rainy summer of 2014, very long periods of rain gave rise to numerous landslides. These processes still present a challenge for us. We need to be able to identify the point at which landslides

From 1972 to 2014, floods, debris flows, landslides and rockfall processes caused damage totalling around 13.2 billion euro in Switzerland. Major individual events dominate the damage assessment report for the period. The floods of August 2005 alone generated damage totalling 2.9 billion euro.

DAMAGE FROM FLOODS, DEBRIS FLOWS, LANDSLIDES AND ROCKFALL SINCE 1972



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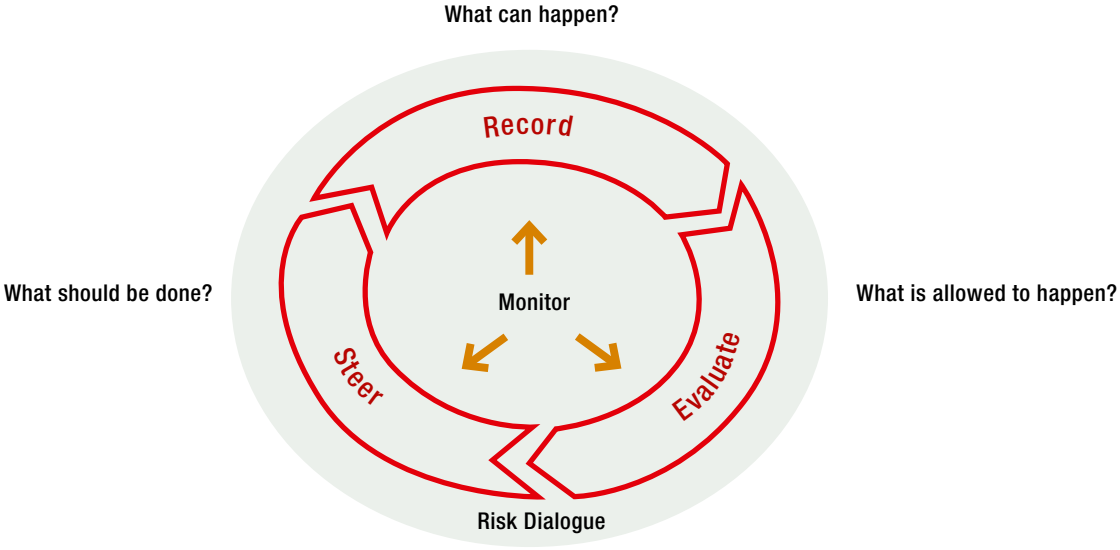


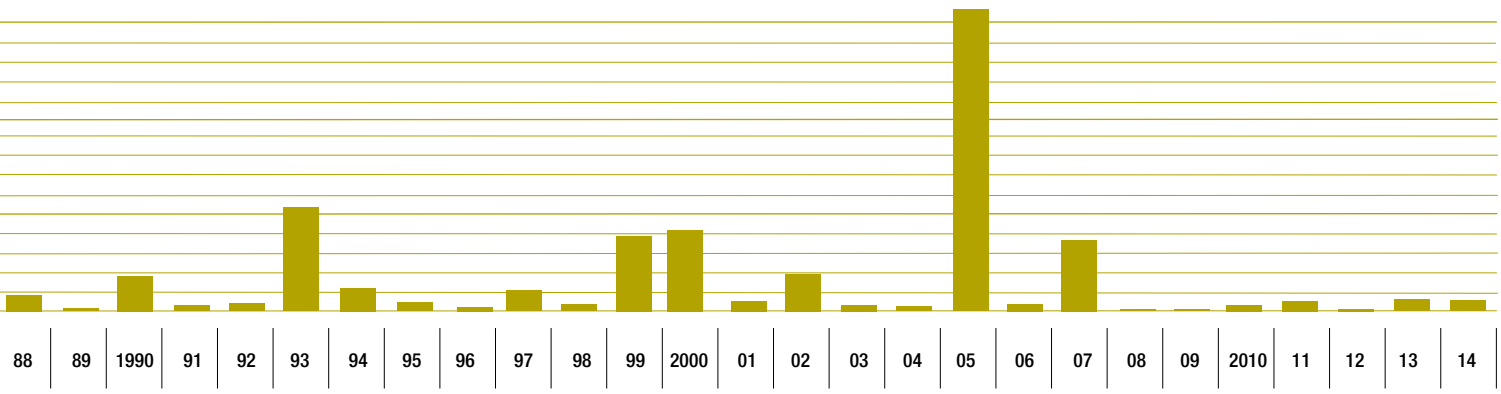
The risk management is forward-looking. It includes the ongoing systematic recording and evaluation of risks and the planning and implementation of measures in response to observed and possible future risks.

become really critical. On the other hand, some of the measures implemented since 2005 proved their worth. We have made clear gains in terms of safety but there is still room for improvement.

What do you have in mind here?

For example, the optimum management of the reservoir lakes in the Alpine region. Instead of continuing to operate the turbines when the flood wave comes, volume should be made available by lowering the water level in advance. This measure is already implemented today on the Mattmark reservoir lake in Valais. A permanently available storage volume reduces the flood risk for the river Visp. On Lake Sihl, upstream of Zurich, the volume is increased through advanced lowering to provide better protection for the city of Zurich.

Based on a parliamentary dispatch, the FOEN was commissioned to compile a report on natural hazards in Switzerland. What are its main findings?



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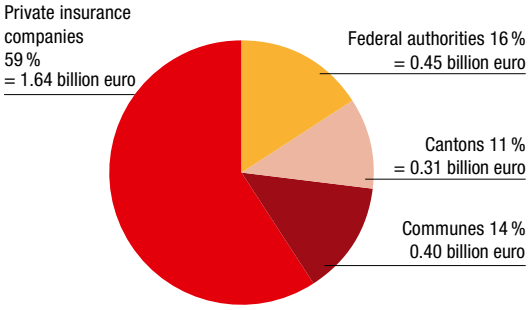

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The price of safety

hjb. *Approximately 2.8 billion euro is spent on natural hazard risk management in Switzerland every year. Of this, 1.6 billion euro is raised by private individuals, of which 830 million is covered by insurance companies. These costs are counterbalanced by enormous benefits. These are generally difficult to quantify as avoided costs do not show up on any balance sheet. However, they can be estimated in some cases. For example, 25 million euro was invested in the structural measures for the protection of the commune of Buochs on Lake Lucerne against flooding of the river Engelberger Aa. During the first subsequent flood event of 2005, this investment prevented damage to the tune of 150 million euro.*

It is impossible for us to imagine how Switzerland would look without natural hazard prevention. Large parts of the country located in the mountain region and river valleys would be uninhabitable due to the lack of safety.

The report shows where we stand today and where action is required for the implementation of integrated risk management. One task that lies ahead is the completion of the hazard information documents. For example, the comprehensive data for surface run-off, which accounts for a major proportion of the damage caused, are lacking. With respect to climate change, we must monitor the different processes in greater detail: the thawing of the permafrost in the Alps, the bedload being released as a result and the corresponding ground motion. What we need to do here is to identify problem areas in good time through systematic monitoring.

What is the role of the protection forest?

The protection forest is very important in Switzerland and, as a part of the infrastructure, it is a component of integrated risk management. Almost half of Swiss forests protect built-up areas and infrastructure and roads and railways. It is far cheaper to maintain protection forests than to build protective structures.

And what needs to be done for the rest of the protective infrastructure?

Maintaining and guaranteeing the functionality of our hazard protection structures is a permanent task. We must think and act in terms of life cycles today and a backlog already exists. The structures themselves must be robust enough to withstand events that exceed their maximum load. Experience shows that, otherwise, major damage may be expected. We must check the design of the protective structures and, if necessary, adapt, supplement and renovate them. An inventory of the relevant protective structures is currently being compiled.

New protective structures should be constructed in such a way that they are adaptable. This is a key concern. Nothing is more stupid than building structures that have to be demolished and replaced when the requirements change. Today's solutions must not become tomorrow's problem. Future generations must also have options open to them. This also necessitates a degree of generosity in terms of the space provided for water bodies.

You have hit on a controversial topic here. Opposition to the legally prescribed minimum space for water bodies exists among farmers who have to give up their already scarce arable land for it.

The additional space is needed not only in the context of flood protection. Water bodies must also be able to fulfil their functions as habitats, connective elements and recreational areas. Providing the necessary space for this is clearly a challenge, but I am convinced that win-win solutions with agriculture can even be found here.

How?

Farmers themselves need the water bodies both to take up water from drained areas and to irrigate

their crops. And in many cases it is they who ensure their maintenance. In doing this they provide a service in the interest of all of society. Rehabilitated water bodies also require care and maintenance. This work should be fairly remunerated so that the loss of land does not involve any loss of income. We also provide financial support for protection forest maintenance.

We must not forget that our ancestors reclaimed huge areas from the water bodies in the valley plains. Between two and three percent of this land should now be returned to the water bodies. This answers the question regarding proportionality. It is important that cases of hardship are alleviated using appropriate measures.

Another field of action is, of course, the implementation of hazard information in spatial planning. What happens with the people who already live in red zones where there is a fundamental ban on construction?

A red zone merely indicates: "Attention, people in buildings risk losing their lives due to natural events." It is necessary to check whether it is still acceptable to allow people to live there. There may be options for keeping the risk at an acceptable level. However, there will be cases in which we must decide that demolition is the only option.

An example of this is the commune of Weggis on Lake Lucerne. Due to the rockfall potential which cannot be controlled at a reasonable cost, five regular homes and holiday homes were demolished. The owners were compensated for the value of the houses but not for the loss of the land. Other cases, for which fair solutions will have to be found, will also arise.

And what can people who live in a blue zone where building is only allowed in future under certain conditions do to ensure the safety of their belongings?

The owners of existing buildings have the option of providing better protection with the help of structural measures. Some cantonal buildings insurance companies already offer to co-finance such property protection measures. More could be done here. For example, a natural hazards renovation programme similar to the energy-related buildings renovation programme could be developed. However, financing such a programme would be a major challenge.

And for new buildings?

With regard to new buildings, we have to reach a stage whereby the natural hazard situation is taken into account in all building and planning processes. All building projects should be hazard-appropriate — irrespective of the hazard zone category in which they are constructed. This is also applicable, not least, to earthquake safety.

Overall, managing natural hazards is a joint task, for which many actors bear responsibility: from the cantons, communes and the business sector to the potential victims. They all have their tasks and responsibilities. The state monitors weather developments constantly, makes hazard documentation available, provides information, issues warnings — where possible in good time — and also guarantees a certain level of area protection. However, individual citizens must also take responsibility on a personal level. We are working at all levels to make society less vulnerable to natural hazards and to improve the knowledge available about the associated risks.

"Overall, managing natural hazards is a joint task, for which many actors bear responsibility: from the cantons, communes and the business sector to the potential victims."

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INTEGRATED RISK MANAGEMENT IN ACTION

Zurich Arms Itself against an Extreme Flood Event

After the floods of 2005 one thing was clear: the river Sihl poses a serious risk to Zurich in the event of a flood. In the case of a 100-year flood, large parts of the city, including the main station, Switzerland's most important rail transport hub, would be affected. Based on a systematic approach, the canton of Zurich is working with all stakeholders to identify all of the options available to reduce the risk. *Text: Lukas Denzler*

Our ancestors knew exactly where it was practical to form settlements. River banks and lake shores were among their preferred locations. The hydropower could be used to operate mills, the waterways provided transport routes and fish supplemented their diets. On the other hand, however, rivers and lakes can breach their banks and shores, and simply do this from time to time.

This also applies to the river Sihl, which enters the river Limmat shortly after Zurich main station, beneath which it flows. Over the course of the flood-rich 19th century, it caused extensive floods in 1846 and 1874. However, Zurich was a very different city at the time.

The last major flood of the river Sihl occurred in 1910. The flood water reached the western bounda-

In 1910, the river Sihl flooded parts of the city of Zurich. Because its riverbed was deeper than it is today, the discharge capacity of the culverts underneath the main station was just about sufficient (photo left).

Confluence of the rivers Sihl (murky water) and Limmat at Zurich's main station in August 2005. Only a last-minute weather reprieve prevented the Sihl from breaching its banks (photo right).

Images: AWEL, the canton of Zurich Office for Waste, Water Energy and Air

ry of the city near Schlieren. "After this event, the entrances of some new houses on Löwenstrasse near the main station were built a few decimetres higher and fitted with steps", explains Matthias Oplatka, Project Manager at the canton of Zurich Office for Waste, Water, Energy and Air (AWEL). This is an extremely effective measure against the risk of flooding. However, this insight was soon forgotten and, today, the entrances to most buildings are at ground level.

In 1937, Lake Sihl was dammed for the Etzelwerk hydropower plant. The power plant provides traction power for the Swiss Federal Railways (SBB) and private railway companies. During periods of intensive precipitation Lake Sihl retains water and the people of Zurich believed for decades that the risk of flooding by the Sihl was under control.

No floods thanks to luck with the weather

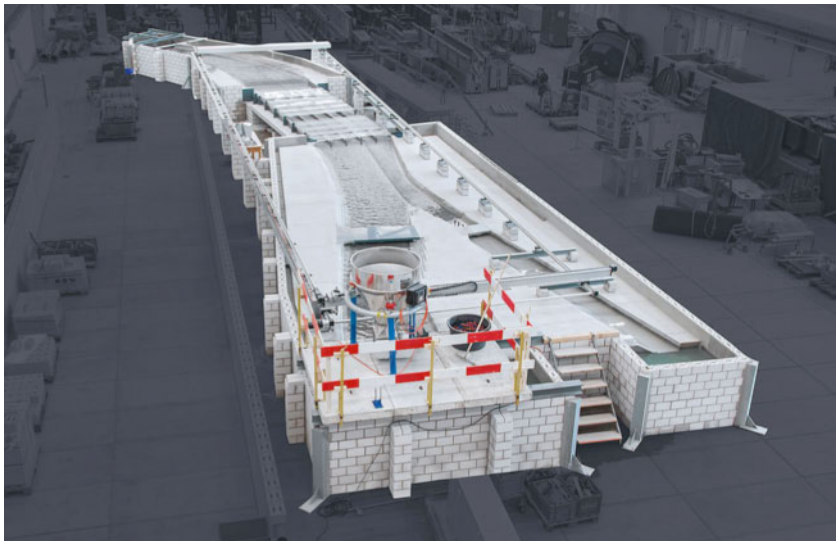
However, in August 2005, the situation was extremely critical. "If Lake Sihl had risen just four centimetres more, so much water would have had to have been released for dam safety reasons that there would have been flooding in Zurich", explains Matthias Oplatka as the river Sihl was

Serious potential consequences for Zurich main station

ld. *According to the SBB Media Department, Zurich's railway junction could be brought to a partial or complete interruption by a flood. The impact on rail travel throughout Switzerland would be enormous. Around half of the journeys made by the approximately one million passengers who use the SBB every day take place in the Zurich region.*

The SBB expects that from a discharge rate of between 360 and 400 m^3/s, the Sihl would breach its banks on the southern edge of the city. Between 30 minutes and three hours later, the flood would reach Wiedikon railway station and shortly after the tracks in the main station. The underground systems would also be affected. The actual flooding of the underground stations and tunnels would unfold over a period of several hours to up to one day. The new Löwenstrasse station, the Museumstrasse suburban rail station and the railway tunnels to Oerlikon and Stadelhofen would also be affected.

The SBB does not expect any injuries to persons in the event of a flood as an evacuation system is in place throughout the entire main station. People in the halls and corridors and in the shopping areas can be kept informed about the nature of the event using pre-recorded texts in German, French, Italian and English. Evacuation of the main station would be ordered by the senior management of the city of Zurich and the SBB's emergency or crisis team.



already filled to capacity at the time. Thanks to the favourable weather conditions, the city was spared. At the same time, heavy storms were raging in the canton of Bern and in central Switzerland. If the centre of the precipitation had been somewhat further east in the catchment area of the Sihl and its tributaries, the Alp and Biber, large parts of Zurich city centre and the main station would have been flooded.

A risk assessment estimates the damage potential from an extreme flood event at 5.3 billion euro.

In 2005, the discharge of the Sihl in Zurich was 280 cubic metres per second (m^3/s) — a value that was only exceeded over the 90-year series of Sihl discharge measurements in 1934 when 340 m^3/s was recorded. In 1910, it was as high as 450 m^3/s. However, at that time the riverbed of the Sihl beneath the main station was slightly lower and there was neither a station shopping centre nor underground stations below the level of the river.

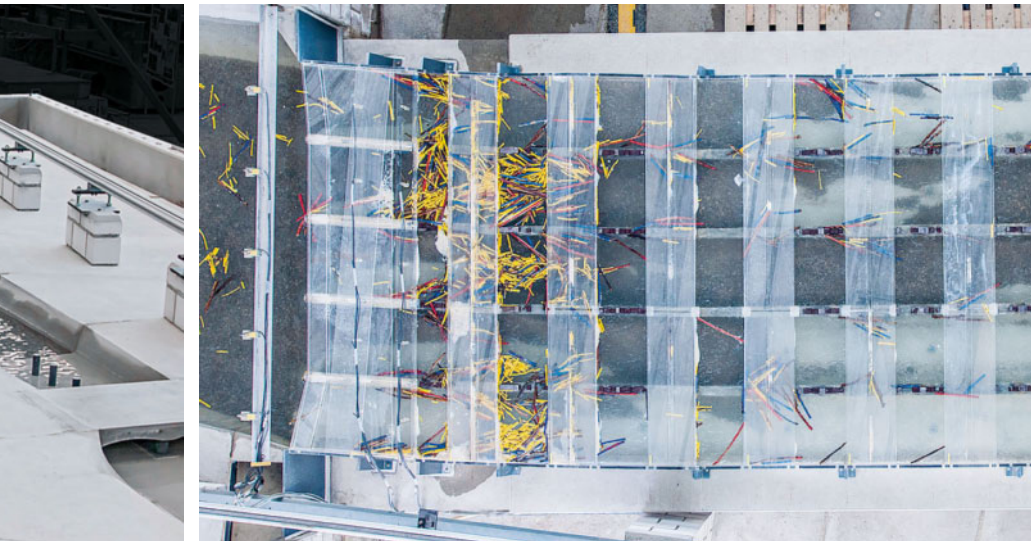
Zurich – a cluster risk

Zurich has a lot of buildings and infrastructure in a small area and its main station is Switzerland's most important railway hub. The city on the Limmat is a concentration risk in itself. A risk assessment carried out jointly by the city, the canton, the cantonal buildings insurance company and Swiss Federal Railways (SBB) in 2010 estimates the damage potential from an extreme flood event with a Sihl discharge of 550 m^3/s at 5.3 billion euro. Up to 3,600 buildings would be affected and four to five square kilometres of urban area would be flooded. According to experts, in extreme cases, peak discharges of between 550 and 650 m^3/s would be possible.

To this would be added economic costs arising from breakdowns and interruptions to the operation of energy, telecommunications and transport infrastructure. The intensive use of basements is very common in Zurich. From a Sihl discharge of around 300 m^3/s already, which can arise statistically around every 30 years, the safety standards recommended by the National Platform for Natural Hazards are no longer complied with at different locations along the Sihl. Moreover, if Zurich's main station were to be closed for an extended period, this would have huge impacts far beyond the city of Zurich itself (see "Serious potential consequences for Zurich main station" page 13).

"Flood protection in Zurich has a very high priority for us", stresses Manuel Epprecht from the Flood Protection Section at the FOEN, which represents the federal authorities in the Sihl, Lake Zurich, Limmat Flood Prevention Steering Committee. The specific challenge here arises from the urban conditions. Solutions must be found and implemented for this densely populated area.

Following the floods of 2005, in which the canton of Zurich escaped lightly with damage totalling 14.5 million euro, the canton took immediate measures. As part of the construction of a new railway line, the riverbed of the Sihl was lowered somewhat beneath the main station. In addition, together with partner consultants, the AWEL developed a forecast model for the Sihl discharge volumes. If a critical situation is



Using a model, the Laboratory of Hydraulics, Hydrology and Glaciology (VAW) at the ETH Zurich is testing how much water the Sihl culverts under Zurich main station can accommodate (photos far left and centre). The small yellow rods in the photo on the right (top view) represent model pieces of driftwood. They are used to examine the risk of a log jam.

Photos: Laboratory of Hydraulics, Hydrology and Glaciology (VAW), ETH Zurich.

likely to arise, it is possible to reduce the water level in Lake Sihl to create retention capacity for the expected intensive precipitation. This measure was ordered by the canton based on forecasts in May 2013 and late July 2014.

Solutions for greater protection

Further measures are planned in the medium term: from 2017 a trash rack in the river Sihl upstream of Zurich should retain driftwood in the event of a flood.

Using a 30-metre-long model of the main station on a scale of 1:30, tests are being carried out at the Laboratory of Hydraulics, Hydrology and Glaciology (VAW) at the University of Science and Technology (ETH) in order to establish how much water the five Sihl culverts below the platforms can actually hold. The aim is to optimise the structures of the main station and the riverbed. Finally, it is planned to adapt the weir regulation of Lake Sihl in compliance with the requirements for dam safety and to exploit the available scope in terms of optimal flood protection.

However, all of these efforts may not reduce the risk in Zurich to an acceptable level. For this reason, further-reaching measures are being examined. At the beginning of the process in 2011, several interdisciplinary teams were given the task of presenting solutions — including unconventional ones.

The proposals were based on the three main ideas: "retaining water", "diverting water" and "channelling water". The result was an overview comprising 35 solutions, which were reduced to five alternatives through an initial process. Two possible solutions ultimately emerged: the first consists in the construction of a relief channel around 20 river kilometres upstream of Zurich, which would divert some of the water from the Sihl in the event of a flood; the second would involve the expansion of the pumped storage system at Etzelwerk power station.

Both alternatives should protect Zurich in the case of an extreme flood event. At investment costs of between 65 and 125 million euro, they are also economically viable. According to Matthias Oplatka, a decision regarding the next steps to be taken may be expected in mid-2015.

Risk analysis reveals weaknesses

The Building Department of the canton of Zurich compiled the flood hazard map for the city in 2009. Based on this, the city was legally obliged to take suitable measures in the areas of spatial planning, water body maintenance, structural flood protection and emergency planning. An implementation strategy also had to be developed within a period of two years.

"Before we were able to start the work, we had to clarify the relevant responsibilities", says Bernhard Kuhn,

> *The city is legally obliged to take suitable measures in the areas of spatial planning, water body maintenance, structural flood protection and emergency planning.*

who was responsible for the coordination of projects in the area of natural hazards until autumn 2014. For the implementation of the hazard maps, the city of Zurich formed a project group, which included representatives from twelve service divisions from five departments, the

AWEL and the cantonal buildings insurance company (GVZ). Bernhard Kuhn identifies the urban risk analysis as an important milestone in the project. A commune must know where the greatest damage potential exists in the case of a hazard event. The results of the analysis also prompted strong support from the city's government.

The city parliament decided to add an article on natural hazards to the city's building code in June 2014. This regulates the consideration of the hazard map in planning applications in greater detail. The city informed the approximately 10,000 owners of buildings at risk from floods twice with personally addressed letters. "Although the personal responsibility of building owners is recognised in principle, it is not easy to gain their support for preventive measures", explains Bernhard Kuhn. Due to their rare occurrence, floods do not feature very prominently in the memory of Zurich's urban population.

Due to their rare occurrence, floods do not feature very prominently in the memory of Zurich's urban population.

Advising property owners

The cantonal buildings insurance company is also in contact with the property owners. The company insures all properties in the canton against damage from fire and natural hazards. "We have intensified our advisory activities in recent years", says Claudio Hauser from the GVZ. In businesses with high turnover, you can often achieve a lot through awareness-raising, particularly when an owner realises the extent of the financial consequences that can arise from an interruption to trading due to flood damage.

According to Claudio Hauser, it is important to consider flood protection measures at an early stage in the planning of new buildings and building renovation projects. In many cases, flood protection measures cannot be carried out in existing buildings at a reasonable cost. Mobile protection measures offer a possible solution in such cases, however.

Flood-proof City Parking

Zurich's City Parking car park is a good example for the use of mobile flood protection. The car park is located near the main station and the river Sihl. The four story car park, which is entirely underground, was constructed between 2002 and 2004. According to Richard Heierli, former Zurich city engineer and president of the building commission of City Parkhaus AG, at the time, flooding was not an issue even in this exposed location. If the water level of the Sihl and Schanzengraben had been slightly higher in 2005, the water would have penetrated the car park through the ventilation flaps. As City Parking's managing director Andreas Zürcher explains, based on the hazard map and other information, it became obvious that the risk had to be reduced — the interruption of operation for several months would cost millions of euro in losses.

Following consultation with the GVZ, the managers decided to adopt mobile flood protection measures which can be assembled by the company's own staff within a period of two hours. The ventilation flaps can be sealed and the areas at risk from flooding at the exit, lift and staircase at the Löwenplatz exits can be protected. However, this is of no use if the procedures do not work in the actual event of an emergency. For this reason, the assembly of the system's components is practised every two years. The cost of these measures was only 125,000 euro.

Strengthening the risk-based approach

Manuel Epprecht from the FOEN views the various preventive measures undertaken in Zurich as exemplary and is impressed by their range and professionalism. Under the auspices of the AWEL, the most important element of this integrated risk management approach was demonstrated in a report. On the request of the FOEN, the "improved channelling" alternative is being kept open in this report should the other two alternatives — the relief channel to Lake Zurich or the combined solution with the development of pumped storage in the Etzelkraft power plant — prove infeasible for political reasons.

As the experience in Zurich shows, the risk-based approach to flood protection must be further strengthened. It is worth investing in risk protection in locations where extensive damage can be expected.

Additional links to the article:
www.bafu.admin.ch/mag2015-2-02

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Preonzo industrial zone is moved

hjb. *It was already known for many years that the area at the foot of Valegión, a mountain overlooking the village of Preonzo in the canton of Ticino, was not a safe place. The rock formations in the precipice are unstable. The village was submerged by a rockfall in 1702.*

After that event Preonzo was rebuilt in a different location. Hence the village centre is no longer at risk – however the part of the commune in which industrial operations were established in the 1960s is. This development would not be authorised today: the area is marked in red on the hazard map.

In 1990, a crack formed on the Alpe di Ròscera directly above the Valegión. The slope has been monitored constantly since then. Sensors measure the earth motions and trigger alarms if they accelerate. The industrial zone was evacuated on a number of occasions, and several rockfalls and landslides have occurred, however they caused little or no damage.

Movement arose again in the Valegión in May 2012. To enable the better monitoring of the slope, a radar system was installed, which allows the movements to be recorded with millimetre precision from a distance without necessitating the installation of measuring devices in the rock face as this would be far too dangerous. The industrial zone was evacuated on 13 May. Two days later, 300,000 cubic metres of rock collapsed down into the valley. Again, there was no damage caused.

The industries resumed operation one week later – but this time only on a temporary basis. In April 2013, the cantonal government of Ticino approved the plan for their voluntary transfer to the industrial zones of Castione and Carasso south of Preonzo. The federal authorities and canton paid seventy percent of the almost 12.5 million euro costs generated by the relocation. The old site has been designated as prohibited for development. "This is the first case of industrial land being designated as prohibited for development due to natural hazards", says Arthur Sandri, Head of the Landslides, Avalanches and Protection Forest Section at the FOEN.

Five companies employing a total of 80 people accepted the offer. Two companies which employ 23 people would like to remain in their premises for the time being. They will have to expect interruption of their operations if the situation becomes critical again. A series of debris flows usually follow in the years after major rockfall events. For this reason, Arthur Sandri suspects that the last two companies will also examine alternative sites for their operations.

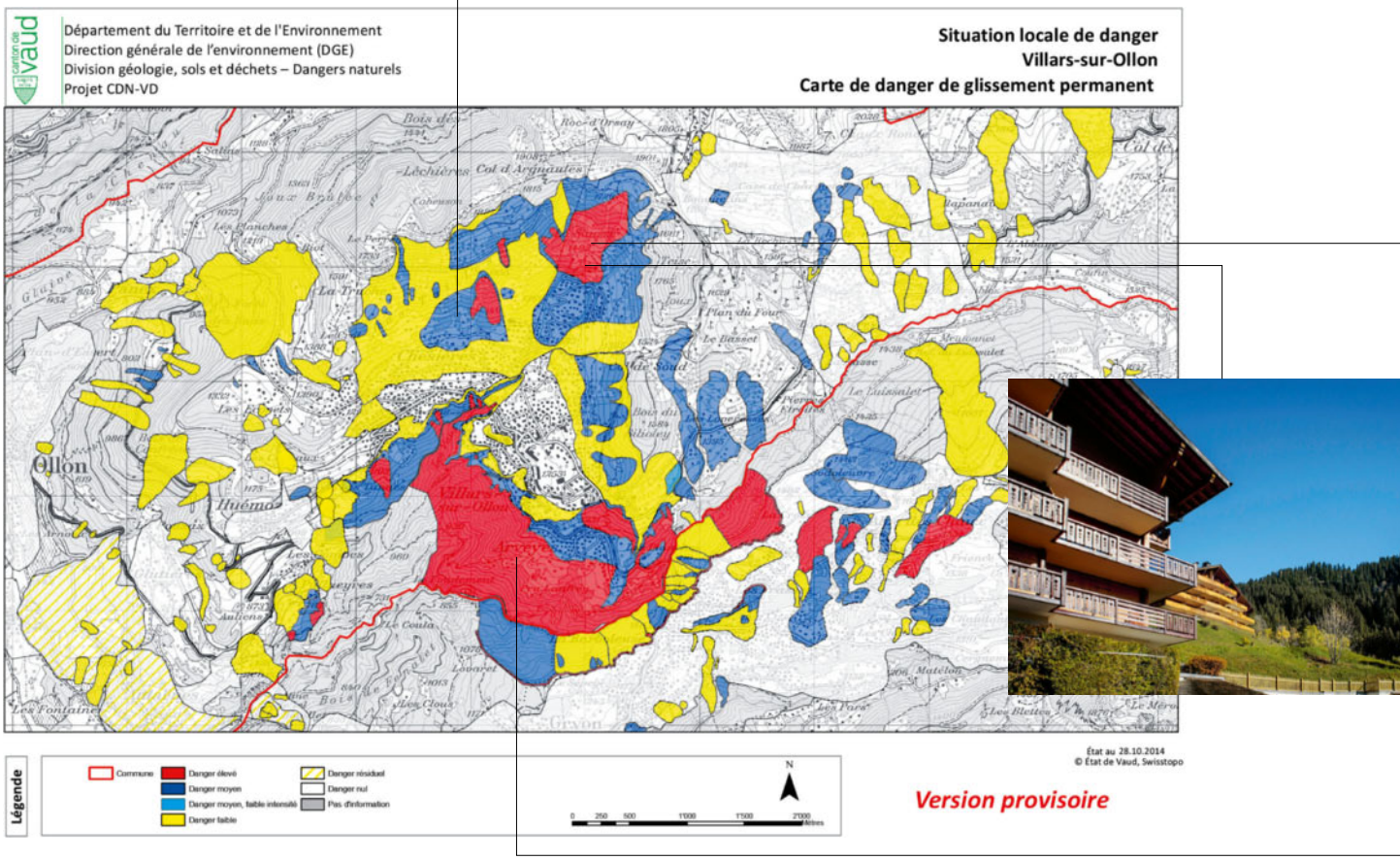
Valegión near Preonzo (Ticino). Photos top: stills from a video of the rockfall on 15 May 2012. The second and third photos from the top show the initiation zone below the Alpe di Ròscera shortly before the event. Bottom: view of the Preonzo industrial area below the debris cone.

Photos: Giorgio Valenti, Giorgio Valenti, cantonal geologist, Ticino

SPATIAL PLANING

Good Maps for Risk Management

Almost all Swiss communes now have hazard maps. The task now is to use this scientific information to plan the measures necessary to protect the population and important material assets and to adapt spatial development. A walk through the commune of Ollon in the western Swiss Alps reveals what is involved here. *Text: Cornélia Mühlberger de Preux, Images: Flurin Bertschinger/Ex-press*



Anyone who walks through the Ollon area would not suspect in a million years that the ground here is moving. This hazard cannot be detected with the naked eye. The presence of a few protective structures is the only thing that might arouse suspicion. Ollon extends from the Rhône plain to the 2112-metre-high Chamossaire peak. The commune consists of 23 villages and hamlets. Old chalets stand serenely beside the newer holiday homes.

A broad spectrum of natural hazards

The area is beautiful and the view magnificent. However, caution is advised as the region, or at least a part of it, is at risk from the entire spectrum of natural hazards — landslides, rockfall, sagging, floods and avalanches. "We even have areas in which three hazard types overlap", reports Pierre-Alain Martenet from the communal building and planning authority.

In Les Tailles, a sediment retention basin was built for the bedload from the stream of the same name and a fence to retain the sediment was erected. Thanks to this measure, the risk has diminished so much that the vulnerable areas could be reclassified from the red ("high risk") to blue ("medium risk") zone.

Hazard map for the Villars-sur-Ollon area. The chalets (photo page 18) are located in the territory of La Saussaz which is at risk from landslides. An inclinometer in the metal cylinder (small photo left) permanently measures the terrain motions here. Large photo: Pierre-Alain Martenet from the building and planning authority of the commune of Ollon in the Arveyes area where the underground is also unstable.

As our expert guide explains, a major landslide occurred near Les Tailles close to La Saussaz in the 1970s. Between 2004 and 2007, the commune had hazard maps compiled — long before the canton of Vaud undertook the systematic mapping of the canton in 2008/09. Several protective measures were implemented as a result: sliding slopes were stabilised and areas at particular risk were designated as prohibited for development. Today, no new buildings can be constructed in the area of La Saussaz — despite the fact that the terrain has been secured and is under constant monitoring.

Yellow, blue red

Before we climb the hills, Pierre-Alain Martenet opens the hazard maps for two parts of the commune which are particularly exposed to risk: La Saussaz and Arveyes. Yellow, blue and red areas feature prominently on the maps. In the

red zones, the risk is classified as "high", which is why the construction of new buildings is prohibited there. People can continue to live in existing buildings as long as an evacuation plan has been defined.

In the blue zones ("medium risk"), special measures must be taken during the construction of buildings. For example, basements must be constructed in solid blocks and reinforced concrete and adjacent sites must be systematically drained. Simple measures, which property owners can carry out themselves to limit any possible damage, usually suffice in the yellow zones ("low risk").

In addition to the hazard level, the maps also provide information about the extent, intensity and probability of occurrence of the individual hazard types. "The hazard maps are an indispensable tool both for protecting the population and infrastructure and for limiting the damage caused by natural hazards", explains Bernard Loup from the Landslides, Avalanches and Protection Forest Section of the FOEN. The risk does not depend solely on the hazard itself but is mainly determined by the use made of the vulnerable areas. The more densely developed, inhabited and used these areas are, the greater the damage potential and, hence also, the risk. For this reason it is important to control developments at an early stage in the spatial planning.

"The compilation of the hazard maps requires a lot of time and the involvement of numerous partners", says Pierre-Alain Martenet. To cover the entire canton of Vaud, around 12,000 maps were compiled, of which 20 cover the commune of Ollon. In addition to the communes, 32 consultancies specialising in geology, water and snow were also involved in this comprehensive project.

Spotlight on Arveyes

We reach Arveyes. At the lower end of the hamlet, there are around a dozen buildings, including a farm. The ground here is unstable too. There are numerous deep permanent landslides, and springs at the foot of the slope point to the presence of groundwater. In the hamlet itself and along the road, water is pumped out of the ground all year round using several pumps, which penetrate to depths of 30 to 60 metres. It has been possible to limit the extent of the ground motions with the help of this system, which was installed in the 1980s.

The Arveyes area is currently classified as a "planning zone". All settlement development has been stopped for the time being until further clarification can be obtained. This should make it possible to pinpoint the risk as accurately as possible and estimate potential risk developments. Depending on the outcome of this process, it will be decided whether sites here can be built on or not. Moreover, the future management of this zone must be defined in a model regulation.

The results will be available between 2016 and 2018 at the earliest. "The assessment of the landslides takes a lot of time", explains Pierre-Alain Martenet, "as they move at a rate of centimetres." There is a lot at stake: the affected sites are very much in demand — firstly because they are very accessible and, secondly, because they provide an amazing view of the surrounding landscape. "This can give rise to conflicts. But the law must be applied: all known risks must be avoided", says the expert.

Limited development potential in La Saussaz

As opposed to this, in La Saussaz, which we have now reached, changes in land use are a thing of the past. Certain plots have been designated as prohibited for development and cannot be built on today. Buildings located in the red zone cannot be extended and houses that are demolished cannot be rebuilt.

In Les Tailles, in contrast, it was possible to stem the hazard risk with the help of a large retention basin. Since 2011, the basin has been collecting material conveyed by the stream of the same name. The downstream area has been reclassified from a red to blue zone. It was possible to secure the existing buildings and sites that remain empty can now be built on again.

"The risks in Ollon could be reduced considerably with the help of technical measures. However a residual risk remains", stresses Bernard Loup from the FOEN. The most efficient measure for the prevention of risks consists in avoiding construction in endangered areas. If buildings are constructed there despite the risk, possible damage can be limited through the use of resilient structures. "The safety of the population can also be improved through the development of an emergency plan", he adds.

Leaving nothing to chance

The definitive hazard maps for the entire communal area of Ollon are now complete or will be soon. What needs to be done now is to inform the population about the situation and integrate the information about the identified natural hazards into the communal structure and land use plans.

According to the Federal Act on Hydraulic Engineering and the Federal Act on Forest, the cantons are obliged to compile hazard maps and to take the information they contain into account in their structure and land use plans. "Hazard maps are indispensable tools for controlling the development of risks in hazard

areas", confirms Roberto Loat from the FOEN's Risk Management Section. They enable the authorities to limit the construction of new buildings in such areas or at least ensure that any building activity and land use there is hazard-appropriate. And they draw the attention of property owners in hazard zones to the fact that they would do well to increase the safety of their buildings by implementing protective measures.

According to the FOEN expert, building regulations will be verified for all hazard levels, including the lowest ones. An analysis of the storms of recent years showed that major damage arose in the yellow and white zones ("residual risk") in which no regulations currently apply. For this reason, it makes sense to define requirements for these zones too. Spatial planning that is based on risks and not just hazards must ensure risk-appropriate use on all hazard levels.

Mapping all of Switzerland

Meanwhile, apart from very few areas, almost the entire inhabited area Switzerland has been mapped. Two thirds of communes have already integrated their hazard maps into their communal land use plans. Compared with other countries, Switzerland is very advanced in this regard and the expertise we have here has triggered a lot of interest abroad (see also pages 35 – 37).

"However, the work here is not finished and it will never be", admits Roberto Loat. The hazard and risk documents must be updated periodically and new phenomena, for example surface run-off, which is responsible for around half of all damage, must be mapped. "Only when we have complete and up-to-date information can we take the correct measures to improve the safety of people and important assets."

Additional links to the article:
www.bafu.admin.ch/mag2015-2-03

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More space for watercourses

hjb. *Up to a few years ago, the river Aire near Geneva flowed through a straight concrete channel. Following periods of heavy rain it repeatedly breached its banks and posed a flood risk to some of the city's neighbourhoods.*

A flood protection project, which is being combined with the ecological upgrading of the watercourse, was initiated in 2002. A long stretch of the streambed was widened. The discharge slowed down as a result and the flood peaks in the lower reaches are dissipated.

Since 2011, the Waters Protection Act prescribes a minimum space for streams and rivers. The buffer strips along banks that already exist today must be extended – particularly along major watercourses. Around 20,000 hectares of land is required for this throughout Switzerland, mainly in agricultural areas. The land will not be lost to agriculture as extensive grassland use is still possible.

However, the areas that will be needed in the 80 years to come for the revitalization of cramped streams and rivers will no longer be available for use as arable land. The area involved is estimated at 2,000 hectares.

Switzerland's total agricultural area – excluding Alpine pastures – is 1.02 million hectares.

The revitalised Aire stream near Geneva.

Photos: Christof Angst

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WARNING AND ALERTING

When the Heavy Rains Fall

Time is money. This principle also applies to the management of storm events: the damage they cause can be reduced considerably if everyone receives timely warnings. Some aspects of this task were poorly managed during the storms of 2005. Thanks to the measures that have been taken since then through the OWARNA project, the warning and alerting system works considerably better today. *Text: Elsbeth Flüeler*

Mobile flood barriers – Beaver tubes – along the river Reuss in Lucerne.
Photo: Beaver Schutzsysteme AG, Grosswangen

2014 will go down in history as the year with no summer. This did not appear to be the case initially as the early weeks of June were warm and dry. Then the temperatures fell and the rain started. Over the entire summer, most regions of Switzerland experienced rainfall at levels ranging between 110 and 140 percent above the norm; in some places they reached as much as 200 percent. The persistent precipitation resulted in floods here and there and sometimes even landslides.

The northern foothills of the Alps were affected on several occasions. However, the damage at national level was limited. According to estimates by the Swiss Federal Institute for Forest Snow and Landscape Research (WSL), the cost of the damage arising from the events in July 2014 was around 80 million euro.

Luck also played a role: in many cases the precipitation in the catchment areas of the already swollen watercourses decreased precisely as the situation became critical.

Event analysis 2005

The measures that had been taken after the events of August 2005 also took effect in 2014. Following this hundred-year flood, the Federal Council — Switzerland's federal government — commissioned the Federal Office for Civil Protection (FOCP) to carry out an event analysis. The FOCP presented its report in 2007. "Its central message was that the authorities were better informed than the population", said Martin Buser from FOEN's Risk Management Section. If the population had been better informed, it would have been possible to prevent a lot of damage and suffering. The total damage sum of 2.9 billion euro would have been half a billion lower. For example, several thousand cars could have been brought to safety — this measure alone would have saved 85 million euro in damage costs.

Earlier warning and alerting

Storms, avalanches and floods always give notice of their arrival — usually days but at least hours in advance. This provides time to take safety measures — e.g. to clear cellars and ground floors, move cars, fill and distribute sand bags, and move people to safe locations — assuming, people are warned in good time. Based on the aforementioned report, the Federal Council launched the "Optimisation of Warning and Alerting in the Event of Natural Hazards" project (OWARNA). The aim is to reduce the damage by 20 percent through the timely provision of information — particularly in the case of floods, by far the most common natural hazard event.

Martin Buser is director of the sub-project "Endurance and Crisis Management". He took up his post at the FOEN on 9 August 2007. Three days later, a two-day period of heavy rainfall began. The water level in Lake Biel exceeded all values recorded since the 1960s — "as if to confirm the urgent need for OWARNA", commented Martin Buser. The crisis management organisation and structures were defined and implemented step by step in the years that followed.

Better and stronger networks

Networks were established between the hazard authorities at federal and cantonal levels. In addition, infrastructure was created which enables action to be taken in emergency cases. Today, the FOEN has a special control room equipped with the very latest technology. The core committee meets here during major hazard events and communicates directly with the responsible federal and cantonal authorities. The chair of the committee informs the decision makers at federal level about the situation and prepares decision-making support documents for them for the timely warning of the cantonal authorities and population.

The crisis committee is supported by the federal natural hazard authorities. In addition to the FOEN, these include: the Federal Office of Meteorology and Climatology (MeteoSwiss), the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) and the Swiss Seismological Service (SED). They constantly monitor and assess

the hazard situation in their specialist fields. If there is the threat of a hazard event, they consult each other in compliance with a tried-and-tested procedure and as soon as predefined criteria are fulfilled they join forces in the Special Natural Hazards Committee. The latter develops forecasts, compiles bulletins and warnings, provides recommendations for behaviour and action, and issues press releases.

Common Information Platform

"The communication with all levels is guaranteed today", says Martin Buser. The Common Information Platform for Natural Hazards (GIN) plays a key role in this process for the cantonal and communal authorities. Measurement and monitoring data on wind, water and snow can be accessed on the platform as can the Special Natural Hazards Committee's forecasts, model calculations, warnings and bulletins.

OWARNA passed the test. "The flow of information was exemplary. The federal organisations cooperated smoothly and efficiently."

In addition, the Special Natural Hazards Committee's 24-hour on-call services is also available to the federal and cantonal experts and management committees. Trained management and intervention forces, supported by natural hazard consultants, are deployed at communal level. "In the event of a hazard, these people and their safety strategies can make a crucial contribution to reducing the scale of the damage caused", explains Martin Buser.

It is understood that such a widely based organisation requires additional staff and resources. Since 2007, 20 posts have been created for OWARNA and materials and equipment totalling 6.7 million euro have been authorised. The increased investments are cost-neutral says Martin Buser: "Instead of investing in protective structures, we spend more money on forecasting, information and warning today."

More detailed information

As part of the OWARNA project, four employees were added to the staff of the FOEN's Hydrological Forecasts Section. Therese Bürgi is Head of the section. "In 2005 there was only one person deployed per forecast shift", she recalls. Today there are always two people on duty and even three in emergency situations. A 24-hour service is also provided at the weekend.

The FOEN also invested in the short-term forecasting. The section now has data available to it from far more precipitation, water level and discharge measurement stations. The forecasting models were also refined. "The hydrological model is familiar with the status of the reservoirs, soil, groundwater and snow cover for all of Switzerland", says Therese Bürgi. "This provides an important basis for the calculation of water level and discharge forecasts." MeteoSwiss added a station on the Plaine Morte in the western Swiss Alps to its weather radar network and another is being constructed on the Weissfluhjoch summit above Davos.

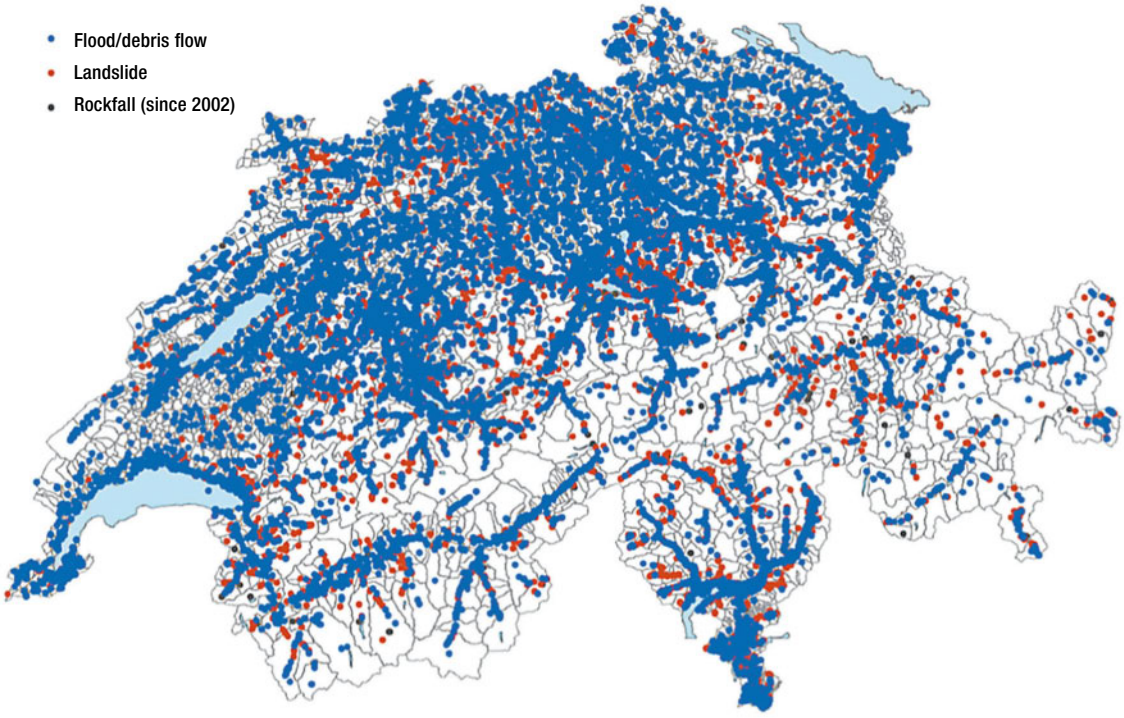
Finally, the FOEN and affected cantons introduced a forecast regulation for the peripheral Jura lakes — Lakes Murten/Morat, Neuenburg/Neuchâtel and Biel/Bienne. The possible increase in the water level in Lake Biel is calculated based on a five-day precipitation forecast for the Aare catchment area. If the calculations point to the likelihood of a significant rise in the water level, the discharge from the lake is increased. In this way, additional volume is created to accommodate the forecasted water. In contrast, if a flood is threatened on the Grosser Emme, which enters the Aare below Lake Biel, the discharge is restricted. The aim here is to enable the Aare to absorb the increased flow from the Emme without breaching its banks.

The test

The test came in June 2013. The volume of rain that fell in some regions within a 48-hour period only arises every 10 to 20 years. In eastern Switzerland, discharge volumes were recorded that can only be expected every 50 years. The situation was reminiscent of 2005.

OWARNA passed the test. "The flow of information was exemplary. The federal organisations cooperated smoothly and efficiently", the Steering

DAMAGING EVENTS 1972–2014 BY MAIN PROCESS



Natural hazards pose a risk everywhere: each point on the map refers to a damaging event that arose in the period between 1972 and 2014 and was reported by the Swiss media. Over 90 percent of the total damage was caused by floods and debris flows. The white areas are mostly located in the Alps and Jura region where there are few or no buildings and infrastructure that can be damaged. *Source: WSL*

Committee Intervention against Natural Hazards (LAINAT) stated in a report on the management of the flood events of 2013. The measures taken were effective: the population was informed about the weather developments every six hours through the media. The local emergency teams were warned and initiated the necessary measures in good time. The regulation of the peripheral Jura lakes also worked perfectly. "Because the responsible authorities (…) placed considerable emphasis on the regulation of the lakes and the prior reduction of the lake water levels, higher water levels and discharges to the Aare, Limmat and Rhine could be avoided", stated the aforementioned report. During the rainy summer of 2014, OWARNA was ready for action again. "Two briefings were held every day", reports Martin Buser. The website www.naturgefahren.ch (see also page 31) published an updated federal natural hazards bulletin almost every day. Extensive use was made of it, also in November 2014 when there were floods in Ticino.

Additional links to the article:
www.bafu.admin.ch/mag2015-2-04

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This mountain pine forest provides sufficient rockfall protection to the Fuorn Pass road close to the Zernez (Grisons) village exit. As a low-cost supplementary measure, felled trees can be arranged crossways to the slope. The rock shown in the image on the left was "caught" by such an impediment.

Photos: Grisons Office for Forest and Natural Hazards; Urs Fitze

BIOLOGICAL PROTECTION MEASURES

A Protection Forest Does More Than You Might Think

The forest provides more effective protection against natural hazards than even experts in the field believed up to now. The newly developed Protect Bio method enables the evaluation of this biological protection service. The procedure was implemented in practice for the first time in a protection forest on the Fuorn Pass road in the Engadin region. *Text: Urs Fitze*

A cylindrical lump of rock the size of a car wheel remained hanging on a pile of felled trees. Forestry workers had piled the stems crossways to the direction of the fall. If the rock had fallen another short stretch down the steep slope, it would have crashed onto the Fuorn Pass road, not far from Zernez village exit. However, it could also have been stopped in its tracks by one of the trees in the dense forest. "That is actually highly likely", says forestry engineer Gian Cla Feuerstein from the canton of Grisons Office for Forest and Natural Hazards. "The stems we have positioned in some places as rockfall protection are just an additional safety measure."

Up to a short time ago, Gian Cla Feuerstein could only have speculated about whether the forest alone provides effective protection against rockfall here. "Based on the topography, the dense forestation and my experience as a forestry engineer, I would have assumed so. However, I could not have vouched for it." For this reason, it was planned to install rockfall nets here on Fuorn Pass road a few years ago — a reliable but expensive protective measure, as such nets cost up to 2,400 euro per metre.

Maintaining forests is considerably cheaper. But can the forest guarantee a similar level of safety to structural measures? To be able to answer this and other questions, the FOEN carried out the project "Effectiveness of biological protection measures", which is referred to as Protect Bio. As part of this project, a method was developed which makes it possible to determine the effect of the forest and other biological protection measures and to take them into account accurately in hazard protection projects.

A rock the size of a medicine ball that could demolish a car without difficulty can be expected to come loose above the protection forest along a 400-metre section of the road every 30 years.

Protection against a 30-year event

The method was used in practice for the first time on Fuorn Pass road. The approximately 800-metre-long stretch of road was due for complete rehabilitation. Hence the opportunity was taken and a mandate was issued for the clarification of the rockfall risk with the help of Protect Bio. The result: a rock the size of a medicine ball that could demolish a car without difficulty can be expected to come loose above the protection forest along a 400-metre section of the road every 30 years. However, statistically speaking, it would be almost impossible for the rock to reach the road.

A large boulder weighing tonnes and several cubic metres in size can be expected to fall every 100 years. In this case too, the forest or rockfall nets would not be ineffective — however, in this case, the possibility of the boulder reaching the road cannot be excluded.

The geologist's eye

The assessment of the rockfall risk begins with a look at the past. What happened in recent years and decades? As a general rule, only spectacular events or those in which damage arose are recorded. The road maintenance crews know about everyday rockfalls — from bits of gravel to fist-sized rocks which can penetrate a car roof — as they clear the carriageway regularly. Marks on the asphalt and repaired areas also bear witness to such events.

The potential initiation area in the massive fissured rock faces over the pass road extends from around 600 m to 2,100 m asl. The slope partly exceeds 45 degrees. The geologist's work consists primarily in taking a look and observing the rock in detail, explains Andreas Huwiler, himself a geologist at the Grisons Office for Forest and Natural Hazards. The rock does not form a homogenous mass on the surface. Instead, it can be envisaged as a mass that has been torn apart by powerful forces, like a bar of chocolate which is easy to break. If the tension is too strong, cracks form.

The interior is also permeated by crevices. To envisage it, the experts examine the rock surface for indicators which allow them to draw conclusions about what is happening inside in its invisible parts — rock faces with different orientations, for example. Scenarios relevant to the assessment of the rockfall risk can be deduced from these structural-geological surveys.

Past events provide further information: Where did the rocks that broke away from the rock face land? How did the terrain influence the trajectory of their fall? The mapping of these "silent witnesses" produces a "map of phenomena", which shows the areas in which rockfall may be expected and how frequently such events may arise.

From the inspection to the simulation …

The event register, map of phenomena and the scenarios derived from the structural geological observations describe the event with "sufficient precision but on no account with the accuracy of a mathematical model, for example", says Andreas Huwiler.

The engineers, who now take the lead, must also live with the remaining uncertainty. They simulate the consequences of the rockfall using a computer model. Based on a three-dimensional terrain model the computer calculates the rockfall track and the forces released by different rock and boulder sizes. The simulation software processes these scenarios until the modelled rockfall events can be evaluated statistically — it is not unusual for this process to involve a few thousand virtual rockfalls.

… and the necessary measures

The nature of the structural measures implemented in response to such events is a question that must be answered by the client. Whether public funding is promised and assigned is a political decision.

In the case of the section of the road near Zernez this means: protection against an event that may be expected every 30 years from a long-term perspective; no structural protection against less frequent events.

Based on previous assessments — in which the insufficiently quantifiable effect of the protection forest as a natural impediment was often ignored — rockfall nets or protective barriers would have had to be built along most of the stretch of road in question.

Unnecessary rockfall nets

However, thanks to the Protect Bio method, it is now possible to present the effect of biological protective measures against natural hazards in a form that enables them to be taken into account in risk assessments. The site gradient, stem density and other factors are incorporated into the simulation for the determination of the forest's retention capacity. In the case of Fuorn Pass road near Zernez, the results are astonishing: no rockfall nets are needed on around half of the affected stretch of road. They are only needed in positions where the forest is thin. And the stems laid crossways to the slope are far better: the only cost that arises here is that incurred in the logging.

Value of the protection forest

uf. *Around half of Switzerland's forest area, 585,000 hectares, is classified as protection forest. It was neglected for decades until a new trend based on a new assessment was introduced in the 1990s. Since then the federal authorities, cantons and communes provide annual funding of around 145 million euro for protection forest maintenance.*

This represents a good investment. The economic value of the protection forest is put at 3.8 billion euro per year. It is imperative that over-aged and uniform stands be regenerated. The protective effect of the forest must sometimes be boosted through targeted structural measures. However, Protect Bio shows that such measures are not always necessary.

The method is a pioneering one developed in Switzerland. There is nothing comparable available internationally. Arthur Sandri from FOEN's Landslides, Avalanches and Protection Forest Section estimates that the consistent use of Protect Bio throughout Switzerland could enable savings totalling several dozen million euro to be made by dispensing with technical protective structures — this increases the value of the protection forest even more.

However, this stage has not yet been reached. The data necessary for the role of protection forest services which are more difficult to quantify for natural hazard processes like avalanches, landslides and debris flows are not yet available. It is planned to use Protect Bio in other locations and, in particular, in the context of these natural hazards in the years to come and to improve its validation. The method will only be adopted as standard when this work has been completed.

Additional links to the article:
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TAKING PERSONAL RESPONSIBILITY

Be Prepared!

To act appropriately in the context of natural hazards, it is essential to be well informed. This is just as applicable to the team in charge of a scout camp as it is for individuals who are out and about on their own. A lot has been done to improve the general public's hazard awareness and competence in recent years. *Text: Peter Bader*

Bern scouts cantonal camp in August 2014 on Lake Biel. The weather was mostly rainy but there was no major storm. Nonetheless, the leadership team would have been ready for one. *Photo: David Bühler*

The scouts had been warned: two thunderstorms had hit the site of the Swiss Gymnastics Festival in Biel in June 2013. They lifted the tents from their pegs and sent portable toilets flying through the air like matchboxes. Eighty-four people were injured, some of them seriously: one died from his injuries in early 2015.

One year after the disaster, Stephan Schwaar, whose scout name is "Schumba", was the main person responsible for the two-week cantonal scout camp in Bern. Around 2000 scouts met on Lake Biel very close to the former site of the gymnastics festival.

Comprehensive safety precautions were taken: the campsite on the meadow was selected with the low flood risk in mind and was 50 metres higher than the level of the lake. The leadership team received information about possible thunderstorms with hazard levels from one to five via the weather pool of the Bern cantonal

buildings insurance company (GVB). The organisers took note of a tree felling zone near the sleeping quarters on the edge of the forest.

In addition, various emergency scenarios were played through in advance of the event — from the clearing or dismantling of the tents in the case of a storm to the evacuation of the site. And because it rained frequently over the two weeks, the scouts cancelled individual activities on the nearby Hagneck canal as a precautionary measure. "The fact that we placed such emphasis on good risk management definitely paid off", says healthcare professional Stephan Schwaar, who resigned specifically from his job to organise the event.

Arrival at the camp site (top). Firefighting was also practised (bottom). *Photos: Henrik Schoop (top), Stephan Schwaar*

Forewarned is forearmed

"Only people who are aware of natural hazards, know about them, and know how to behave correctly and protect themselves, can act responsibly", says Martin Buser from the Risk Management Section at the FOEN. This applies equally to the event organisers and individuals. Various measures have been implemented since the devastating storms of summer 2005, which highlighted certain weaknesses in this regard. The basis for this action is the "Optimisation of Warning and Alerting in the Case of Natural Hazards" (OWARNA) report (see also pages 22 – 25).

At the launch of the new natural hazards internet portal www.naturgefahren.ch in July 2014, FOEN Director Bruno Oberle described it as the "latest building block" in the implementation of the OWARNA project. Previously, if you wanted to find out whether it would be safe to travel from home to your holiday house on a stormy rainy winter's day, you had to look for information separately from MeteoSwiss, from the FOEN and from the Federal Institute for Snow and Avalanche Research (SLF). The new portal, which involves the cooperation of all of the relevant federal authorities, shows the current hazard situation on a single easily readable map. Whether you're planning a mountain hike, ski tour or river cruise, with a few mouse clicks you can access comprehensive information about any storms, heavy rain, avalanches, floods or forest fires that may be looming. Recommendations for behaviour before, during and after natural hazard events round off the detailed content provided on the website.

"The natural hazards portal was a success from the outset", says Barbora Neveršil, FOEN Success Officer for Natural Hazards. "50,000 hits, the maximum for a single day, were recorded in July 2014 when there was heavy rain and various floods around the country."

Local expert knowledge is important

The availability of local expert knowledge on the ground is also indispensable for the management of serious natural events, says Martin Buser, who worked as a fire brigade commander in his home commune before taking up his position at the FOEN. The FOEN organises courses for cantonal natural hazards trainers who, in turn, prepare local natural hazards consultants in the communes and regions for their work. These roles are carried out by locals from the police force, fire brigade, health service, technical operations and civil defence as well as forestry workers who are very familiar with their commune territories.

On the training course they learn how to assume an advisory role in the preparatory phase, during a hazard event that results in damage and during the damage analysis — "to complement the existing experts, as outsiders with a clear head", as Martin

Buser notes. They can assume a consultancy role for emergency and evacuation planning, providing concrete suggestions on the timely removal of cars from a hazard zone or on the clearing of cellars and basements.

The concept of the local consultants has been well received: around 300 of them are already at work. The vast majority of cantons have already requested the training documents from the FOEN.

Many house owners remain indifferent

The cantonal buildings insurance companies also play an important role in raising awareness about natural hazards. It is very much in their own interest for house owners to be familiar with natural hazards and to act in a hazard-appropriate way. The fact that action is still required in this regard is demonstrated by a study carried out in 2014 by the foundation for prevention of the cantonal buildings insurance companies (KGV). A survey of house owners and building clients revealed that their interest in the topic of natural hazard prevention "appears to be rather minimal" and "risk perception or assessment of risk is not generally very prominent". This is all the more annoying as "with the necessary knowledge and three sand bags in front of the cellar window, you can prevent several thousand euro worth of damage".

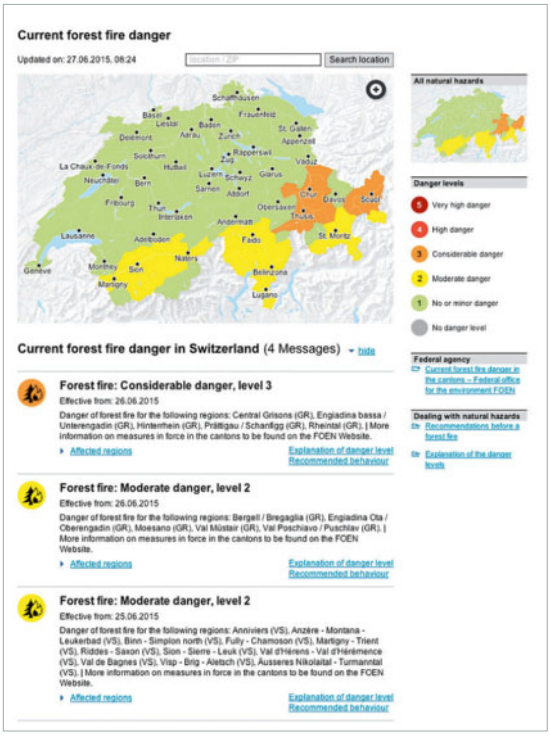
Various actors are trying to eliminate this deficit. The Swiss Engineers and Architects Association (SIA) offers further training courses and provides a brochure on the consideration of natural hazards in planning applications to download on its website. Together with the cantonal buildings insurance companies and other partners the SIA also operates the website www.schutz-vor-naturgefahren.ch. The National Platform for Natural Hazards also provides information for building clients and owners on its website.

The buildings insurance companies themselves run regular campaigns and provide weather alarms, information material and advisory services. Finally, the majority of natural hazard maps (see pages 18 – 21) can be viewed on the internet.

Natural hazards at school

Dealing with natural hazards has recently also become an element of the school syllabus. The new Lehrplan 21 syllabus, which can be introduced by the cantons in the years to come, contains the natural hazard prevention element of the subject "Nature People Environment". A corresponding project for the lower grades already exists in the canton of Geneva explains Martin Buser: "Natural hazards surround us throughout our entire lives. So it is important to familiarise children and young people with them at an early age and to use them as knowledge multipliers."

In the flood-prone Mattequartier of Bern, the efforts made have already borne fruit. People's behaviour has changed, Martin Buser is pleased to report: "They are attentive, comply with the defined threshold value, and use mobile flood protection and sandbags where necessary. As a result it was possible to prevent serious damage in recent years."



One click on www.naturgefahren.ch and you know everything about all imminent hazards.

Additional links to the article:
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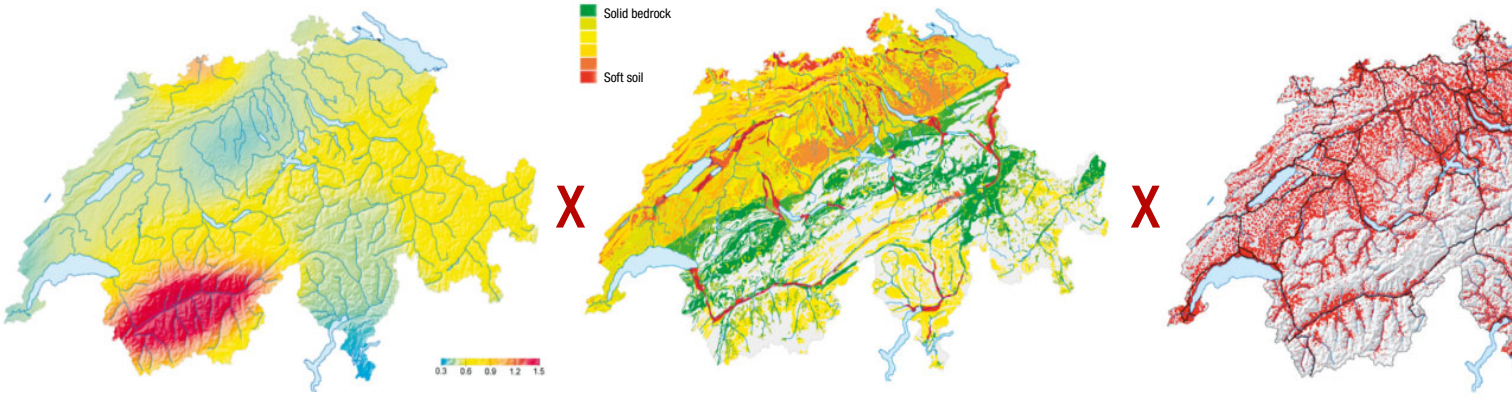
PROTECTING INFRASTRUCTURE

Shaking Up Earthquake Protection

Collapsed buildings and bridges are among the horrifying images produced by earthquakes. However, the less spectacular consequences of earthquakes can also bring a country to a standstill, for example when key infrastructure systems are damaged. The FOEN is committed to ensuring better protection against earthquakes. *Text: Lucienne Rey*



Seismic hazard | Soil condition | Affected assets

When the ground shook on 9 December 1755, Valais must have been seized by widespread fear and terror: the tremors are said to have been "hideous and horrifying" and, as one chronicler reported, everyone expected that "Brig and all of the surrounding stone buildings would obviously collapse in a heap and be buried under the rubble".

The tremors were felt over a wide area and damage also arose, for example, in Bern and Lucerne. The victims were terrorised, not least, because the earthquake in Lisbon had claimed tens of thousands of lives just about a month or so earlier. The enlightened public of the outgoing 18th century was highly aware of the threat posed by earth tremors. The philosopher Immanuel Kant (1724–1804) had even written an essay on the earthquake "which towards the end of the year 1755 shook a great part of the Earth". In it he discussed both the disaster in Lisbon and the subsequent earthquake in "the mountains of Switzerland".

All of Switzerland at risk

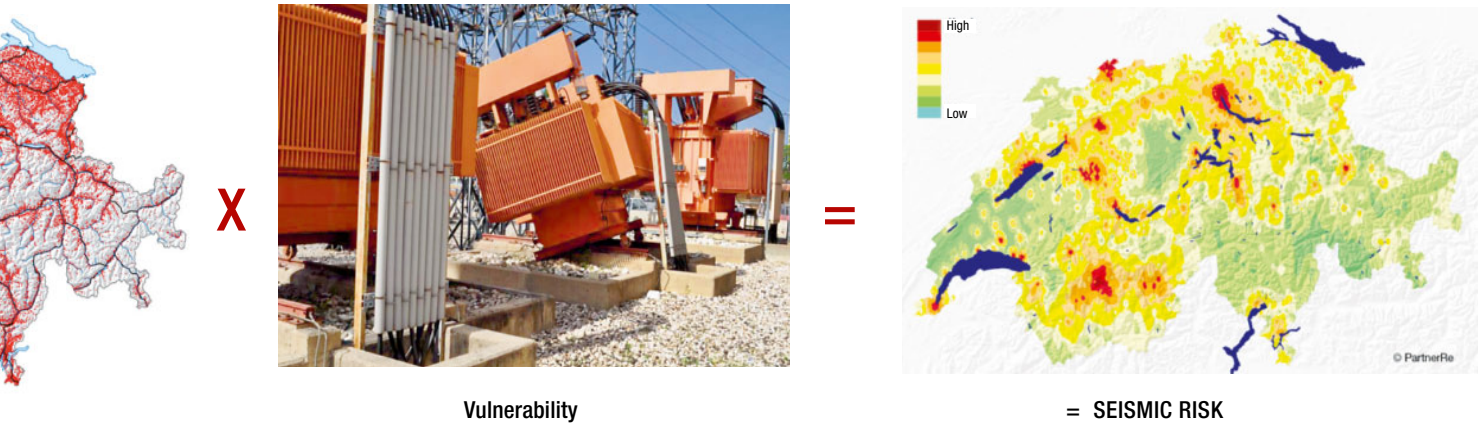
The threat posed by earthquakes has generally faded from the collective memory in Switzerland today as the last major earthquake took place almost 70 years ago. "Memory is dominated by the most recent natural hazards", observes Sven Heunert from the Coordination Center for Earthquake Mitigation at the FOEN. After a winter of heavy snow, avalanches are seen as particularly dangerous and people fear flooding following a season of heavy rain. "And yet, earthquakes are the one hazard, from which no region is immune", explains the earthquake expert.

And the destruction caused by earthquakes is often extensive: the earthquake of 25 January 1946 in Sierre (Valais), which according to the Swiss Seismological Service (SED) reached a magnitude of 5.8, cost four people their lives, damaged around 3,500 buildings in Valais alone and caused damage to the tune of millions of euro. To compare: the earthquake in Brig

in 1755 had a magnitude of 5.7 while a magnitude of 9 has been recorded retrospectively for that in Lisbon.

The map of earthquake hazard zones produced by the Swiss Society of Engineers and Architects (SIA) shows that the hazard level for a large part of Switzerland is low, however the strength of the ground motions is not determined by the magnitude of the earthquake alone. A lot also depends on the local underground. In addition, the intensity of land use in the affected area plays a major role in the extent of the damage caused. Or as Seven Heunert puts it: "Conurbations like Lausanne or Bern are at greater risk than a small town in the Basel region — even if the seismic hazard there is greater."

The extreme vulnerability of such network infrastructure is demonstrated by the fact that not even spectacular natural hazard events are needed to bring the lifelines of the economy and society to a halt: all it took on 28 September 2003 was for the branch of a fir tree to come too close to the power line over a Swiss Alpine pass. This caused a short circuit, the electricity jumped over to the tree and flowed into the ground. Or to put it in more technical language: an earth fault interrupted the supply to the north-south transit axis of this European electricity network. Due to faulty switching in Italy, this triggered a serious chain of reactions. "From 03:27 complete power failure in Italy", is the Federal Office of



The seismic risk is the product of the seismic hazard (probability of occurrence), the condition of the underground, the affected assets (settlement density) and the vulnerability of buildings and infrastructure. *Maps and image: Swiss Seismological Service (SED), 2009 CatFocus Partner Re, FEMA*

Vulnerable networks that span the entire country

Anyone planning to construct a building should consider the possibility of seismic shocks. This would also be in the interest of the future owners: if their property is damaged by an earthquake, they must generally bear the cost alone. At present there is only one canton in Switzerland in which the cantonal building insurance includes the seismic hazard.

To get to grips with this risk throughout Switzerland, the federal authorities launched a programme of earthquake mitigation measures in 2000. One of its core points consists in making federal buildings earthquake-proof. Another is protecting the infrastructure in the federal authorities' sphere of influence. This concerns, in particular, the electricity supply network, the national roads and rail transport system.

Energy's succinct statement in its report on the event. In the event of an earthquake, locally limited damage to the supply network itself can affect the supply in remote areas or even bring it to a standstill. Moreover, earthquakes are such extensive phenomena that a large number of damage locations may be expected. Infrastructure networks that cover an entire country are even more vulnerable. To protect these networks against the consequences of earthquakes, the federal authorities are initially focusing on so-called vulnerability studies. These identify weak points, the protection of which is a matter of priority.

Discovering critical points

The FOEN carried out just such an analysis with the electricity sector. Based on the findings of the study,

the Federal Inspectorate for Heavy Current Installations (ESTI) issued a new guideline on the seismic protection of the electricity power supply to prevent a national blackout. The guideline defines requirements for the relevant elements of the electricity supply network, for example the anchoring of transformers. It also specifies the minimum slackness of the conductor cables. This means that conductor connections must hang loosely enough so that they do not tighten in the event of abrupt movements of the underground and damage the equipment. The provisions are staggered on the basis of the earthquake zones and voltages involved and also take the local ground conditions into account.

Vulnerability analyses also reveal where preventive measures offer the greatest benefit. Transformers and switchgear are the key elements in the substations — that is the components in the electricity network that connect different voltage levels with each other. "A simple measure consists in preventing the control cabinets from falling over", explains Sven Heunert. In many cases, it is sufficient to attach them to the wall using steel brackets. Ensuring sufficient stability for the transformers is also very useful. "If a large transformer falls over and is damaged, it takes months for a replacement to be delivered", explains the FOEN expert.

"Nobody feels entirely responsible for elements like a non-load-bearing wall or a transformer."

Sven Heunert, FOEN

The fact that unconventional measures can also contribute to achieving the desired objective is demonstrated by the Valais cantonal police organisation: it has secured its most important computers specially using strong Velcro fastener. In doing this, it adopts the kind of thinking which, in Sven Heunert's view, should always lead the way: "Everyone must think about the safety of the support structure and ask: What could fall, what is at risk and what could be dangerous?"

A challenge for planners and builders

Overall, Sven Heunert regrets that not all training courses for planners and builders pay sufficient attention to earthquake protection. In many cases, little or no attention is paid to secondary building components, in particular installations. "Nobody feels entirely responsible for elements like a non-load-bearing wall or a transformer." And yet it is precisely these elements that must be tailored to being exposed to the kind of forces that arise in the case of an earthquake.

Earthquake protection poses considerable challenges for the railways. Due to the diversity of its components, the complexity of its network is difficult to beat. "In addition to complex load-bearing structures like railway stations with high occupancies and bridges, the Swiss Federal Railways (SBB) also have their own electricity network and a complete communications network that controls it", explains the FOEN expert. As a result, the railway infrastructure is also suitable for making many planners aware about earthquake protection: "The railway company commissions numerous engineering consultancies which are forced focus on seismic safety as a result."

Complex structures have major damage potential

In the case of the roads, bridges are the component at particular risk from earthquakes. Accordingly, the Federal Roads Office (FEDRO) has been surveying the seismic safety of the approximately 4,000 national road bridges based on a two-stage process. Up to now, weakness have been discovered in only a few structures which had to be remedied immediately.

One of these is the Chillon viaduct at Lake Geneva. At peak times, up to 7,300 vehicles drive across it. In view of this intensive use, it was clear that seismic safety measures had to be implemented in the context of the general maintenance planning. Many of the viaduct's concrete joints were replaced with special seismic isolators. These act as elastomeric bearings, absorb the kinetic energy from the earthquakes and thus separate the structure from the movements in the underground.

The impressive structure on the banks of Lake Geneva is representative of a general trend in the development of infrastructure and settlement: complex and expensive structures have generated significant increases in the damage potential. If an earthquake as strong as that in Valais in 1946 were to arise in the vicinity of a major city today, it would cause damage costing between 2 and 5 billion euro.

Additional links to the article:
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INTERNATIONAL COOPERATION

Drawing on Switzerland's Experience throughout the World

Switzerland's expertise in dealing with natural hazards is valued throughout the world. It ranges from emergency aid to disaster preparedness and, as a result, is availed of in many countries and by many organisations like the UN and OSCE. *Text: Viera Malach*

Bosnia and Herzegovina after the devastating storm of 2014: landslides and floods, for example on the river Bosna, destroyed numerous buildings.

All photos: Hugo Raetzo, CSA

Hugo Raetzo completed his latest foreign deployment in the state of Bosnia and Herzegovina as a member of the Swiss Humanitarian Aid Unit (SHA). That was in mid-May 2014. The worst floods for 120 years had inundated one third of the country. Large areas of neighbouring Serbia were also under water. Almost one million people had to leave their homes, temporarily at least, and 60 people lost their lives. Numerous countries sent aid workers. Switzerland was represented on ground by two SHA operations teams and army helicopters.

Hugo Raetzo works in the FOEN's Landslides, Avalanches and Protection Forest Section. "Although water experts were primarily in demand in Bosnia and Herzegovina to deal with drinking-water issues, there was a risk of landslides, rockfall

Large areas in the north-east near Bjieljina were under water (left), a house destroyed by a landslide (right), flooddamages south of Maglaj and by the Mala Rijeka torrent (next page).

and debris flows in several hundred locations which, as an expert for geological hazards, I had to assess", he reports. "For example, we were able to give the all clear in a completely cut-off mountain village as the location was stable. It was extremely important that independent experts evaluated the hazards", he adds.

Former opponents in war join forces for disaster risk reduction

As Hugo Raetzo explains, the retrospective analysis of the disaster revealed that to be better prepared for future flood events the two Balkan countries need better measurement networks, early-warning systems and emergency organisations: "In the case of the flood hazard in the main valleys, it would be possible to warn the population in good time based on our hydrological forecast model. The local intervention forces could then guarantee the necessary protection and, if necessary, organise evacuations." Cross-border disaster risk reduction now offers the former opponents in war, Serbia and Bosnia and Herzegovina, the opportunity to improve the management of their shared rivers, the Sava and Drina.

Both states received support for disaster risk reduction and reconstruction from the Organization for Security and Co-operation in Europe (OSCE), neighbouring countries and Switzerland. The Swiss Agency for Development and Cooperation (SDC) and the State Secretariat for Economic Affairs (SECO) temporarily shifted the focus of their long-term eastern cooperation programmes to reconstruction, and planned projects are now being supplemented with measures for disaster risk reduction.

Risk reduction on the OSCE agenda

During its Chairmanship of the OSCE in 2014, Switzerland had identified disaster risk reduction and natural hazard management as focal issues. For example, a meeting for the preparation of the OSCE Economic and Environmental Forum dealt specifically with these topics. Based on two field visits in the canton of Valais, the FOEN, SDC and local authorities demonstrated to the conference participants from 57 states what kind of joint preventive measures against floods, avalanches and debris flows are possible, and what kind of residual risks remain.

Switzerland has made a name for itself in the international arena as a mountainous country with a long tradition in the management of natural hazards which is willing to provide efficient help and support. "Because risk reduction is on the agenda of a security organisation like the OSCE, Switzerland continues to offer its expertise", explains Adrienne Schnyder, OSCE

Programme Officer, SDC/Humanitarian Aid. The OSCE is focusing on the topic of water this year under the Chairmanship of Serbia. Better flood management is an aspect of this topic.

Risk management in development cooperation

Because extreme weather events put the progress made in combating poverty at risk in some locations, the SDC upgraded disaster risk reduction to a key issue. The FOEN and SDC cooperate closely with the aim of strengthening the resilience of the local population and establishing a risk management system based on the Swiss model and tailored to local conditions.

"Thanks to the expert interaction between the FOEN and SDC, Switzerland's experience can be incorporated into the projects in developing countries", says Carolin Schärpf, who coordinates the cooperation between the two agencies as a staff member of the FOEN Hazard Prevention division. The paradigm shift — from pure hazard prevention to integrated risk management — that has taken place in Switzerland in recent years is also reflected in the country's international cooperation activities.

A neutral expert in Thailand

Swiss aid is valued throughout the world because it places the civil population at the centre of attention and because its experts act independently and impartially. The SHA's aid and, hence also the FOEN's expert knowledge, is constantly in demand in this context.

For example, Thailand called on the SHA's experts for help during the horrendous floods of November 2011. Following an extraordinarily long monsoon, the Chao Phraya river had breached its banks and 400 people were killed. Approximately 160,000 square kilometres of land were flooded, an area four times the size of Switzerland. The loss of production in the major industrial complexes of the Ayutthaya province, which were flooded for weeks, had impacts on the global economy.

Urs Nigg from the FOEN's Flood Prevention Section was also part of the SHA team. "The SHA had to provide a neutral assessment for the domestic political debate as to whether the support staff had made errors in the emergency operations", he reports. This was a difficult time in the country, which was already torn by deep political divisions. The SHA team also had to identify feasible preparedness measures. Industrial plants like those in the province of Ayutthaya cannot simply be moved to the mountains. "Nonetheless, it is possible to reduce damage considerably with the help of careful property protection measures and the transfer of sensitive objects to more elevated

locations", says Urs Nigg. It has yet to emerge which elements of his analysis, the proposed protective measures and spatial planning regulations will be implemented.

PLANAT throughout Europe

Since 1997, the expertise gained in the area of integrated risk management in Switzerland has been pooled and constantly improved by the National Platform for Natural Hazards (PLANAT). "As an extra-parliamentary consultative commission appointed by the Federal Council, PLANAT is the oldest platform of this type in Europe", explains Wanda Wicki, who was Director of the PLANAT secretariat until the end of 2014. Since 2011 an annual exchange has been taking place between the 18 platforms which now exist in Europe. "Not all countries have sufficient capacity for risk management. However, their capacity can be strengthened through active networks."

Hence, Kosovo approached PLANAT two years ago requesting expert support for the government in Pristina for the development of a national strategy for dealing with natural hazards. This resulted in "exciting strategic cooperation", reports Wanda Wicki. She pleads for the establishment of as many platforms as possible like PLANAT. "The participatory approach is a priority for us." An overarching and networked strategy can only be achieved with the involvement of all responsible actors.

"Because the economic losses arising from natural disasters are very high, the countries at risk from such hazards need corresponding support", adds Markus Zimmermann, who represents the SDC in PLANAT and has specialised in hazard prevention since the early 1990s as a member of the SHA. Comprehensive knowledge of the risks is crucial, he stresses. Public and private investors should avoid the creation of new risks through appropriate planning, and reduce existing risks through clear prioritisation. In addition, governments must create a favourable environment for disaster risk reduction. These points were highlighted by the Swiss working group for the Third UN World Conference on Disaster Risk Reduction which took place in Japan in spring 2015 (see box). The SDC, FOEN, PLANAT, Federal Office for Civil Protection (FOCP) and a network of non-governmental organisations which deal with disaster risk reduction were represented in the working group.

World Conference on Disaster Risk Reduction

vm. *Natural disasters affect rich and poor countries alike and cause huge human and economic losses. For this reason, the topic of disaster risk reduction (DRR) is very high on the international agenda. This was also demonstrated by the Third UN World Conference on DRR from 14 to 18 March 2015, at which delegates from 187 states, non-governmental organisations, science and the private sector adopted the Sendai Framework for Disaster Risk Reduction 2015–2030.*

Switzerland played a key role in the preparation of the conference. This was also the case for the Second World Conference in 2005 in Kobe Japan where the "Hyogo Framework for Action: 2005–2015" was adopted. In keeping with the aim of promoting the link between humanitarian aid, risk-conscious sustainable development and climate change, Switzerland also advocated for the strengthening of an integrated DRR approach in the formulation of the new framework document at the 2015 conference.

Additional links to the article:
www.bafu.admin.ch/mag2015-2-08

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Publication details 2/15 May 2015 | The FOEN's *umwelt* magazine, on which this English-language edition is based, is published quarterly; subscriptions available free of charge; ISSN 1664-4808. | **Publisher:** Swiss Federal Office for the Environment (FOEN). The FOEN is an office of the Swiss Federal Department of the Environment, Transport, Energy and Communication (DETEC) | **General project management:** Bruno Oberle, Thomas Göttin | **Concept, editing, production, marketing:** Jean-Luc Brülhart und Georg Ledergerber (project manager/managing editor), Charlotte Schläpfer (deputy); Hans Peter Willi, Carolin Schärpf and Hansjakob Baumgartner, Joël Käser and Andrin Ruefer (online), Valérie Fries (Editorial secretariat) | **External collaborators:** Peter Bader, Urs Fitze, Elsbeth Flüeler, Beat Jordi, Viera Malach, Cornélia Mühlberger de Preux, Lucienne Rey | **English translation:** Susan Cox | **Production and layout:** Arbeitsgemeinschaft Atelier Ruth Schürmann, Lucerne | **Closing date for contributions:** 27 March 2015 | **Editor's contact information:** FOEN, Communications Division, Redaktion umwelt, 3003 Bern, Tel. +41 (0)58 463 03 34, Fax +41 (0)58 462 70 54, magazin@bafu.admin.ch | **Languages:** German, French; English (dossier only); Italian (online dossier only) | **Online:** The magazine content is available at www.bafu.admin.ch/mag | **Circulation of this edition:** 3,000 English copies, 51,000 German copies 19,000 French copies | **Paper:** Refutura, recycled from 100% waste paper, FSC-certified with the Blue Angel seal; climate neutral and low VOC printing | **Printer:** Swissprinters AG, 4800 Zofingen, www.swissprinters.ch | **Contact information for orders:** BBL, Vertrieb Bundespublikationen, CH-3003 Bern, Tel. +41 (0)58 465 50 50, Fax +41 (0)58 465 50 58, verkauf.zivil@bbl.admin.ch, www.bafu.admin.ch/mag2015-1 |

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