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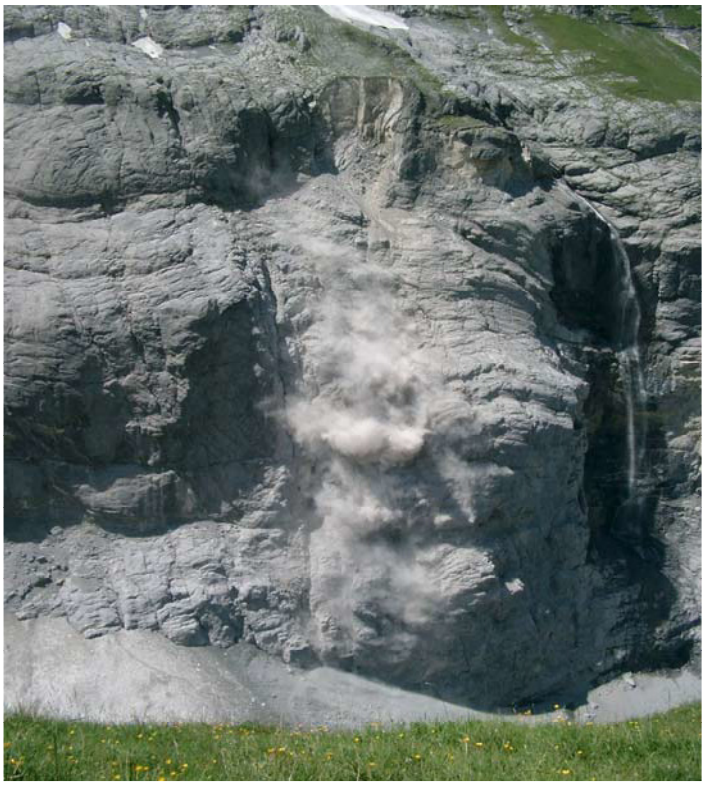
HOTSPOT PAPER

PROTECTION AGAINST NATURAL HAZARDS

Platform on Natural Hazards of the Alpine Convention PLANALP



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1 Hotspots in integral natural hazard risk management

1.1 Introduction

Safety is a basic human need and one of the key requirements for the welfare of society. The same applies to protection from natural hazards. The worrying increase in weather-related incidents in the recent past has made us painfully aware that we can never fully control the forces of nature.
Scientists predict a further increase in extreme weather and the associated natural hazard-related events over the coming decades as a result of climate change. Consequently, instead of spending large sums attempting to combat such events, we would be well advised, wherever possible, to avoid them in the future. This may also mean refraining from types of land use that place people and property at potential risk, if they cannot be protected at reasonable cost.

It is believed that, as a consequence of glacier melt and thawing permafrost, the frequency and magnitude of floods and debris flows, rock falls and slides, avalanches and the destabilisation of entire hillsides will increase to a greater or lesser extent. An increased occurrence of low tide periods or droughts is conceivable in some areas. A change in processes is also possible, such as debris flowing down torrents where only floods have occurred so far. The effects of climate change on the mentioned processes will impact differently on different regions.

The PLANALP platform within the Alpine Convention focuses on the principal, predominantly meteorologically-driven, natural hazards affecting the Alpine space, namely floods, debris flows, land slides, rock falls and avalanches.

Over the course of a year, PLANALP members held three meetings at which they discussed the key problems of natural hazard prevention in the Alpine region in depth.

The following "hotspots" were evaluated as areas in which priority action is needed:

- Adapting to climate change **– Hotspot 1**
- Risk dialogue **– Hotspot 2**
- Residual risk **Hotspot 3**
- Land use planning – **Hotspot 4**

PLANALP also drew up potential problem-solving strategies in order to accelerate the development of solutions to these key problems. These strategies provided a basis for a set of conclusions and recommendations.

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1.2 The basis of integrated risk management

Integrated risk management incorporates all measures that contribute to the reduction of damage caused by natural hazards. These include, for example, emergency management during disasters, the maintenance of protective structures, repair work, the maintenance of protective forests and structural measures. It is a fact that technical measures have a long tradition as counter-measures. In fact, early warning systems, hazard maps, organizational measures and other programmes were introduced as long ago as the 1960s.

Fig. 1
All activities are necessary to maintain security with regard to risks posed by natural hazards to humans and their infrastructures. The solutions on which to act are those that offer the potential for an integrated approach.

The aim of PLANALP is to support the management of risks caused by natural hazards in an integral way, to maintain such risks at a level that is accepted by society and that avoids increasing vulnerability.

2 Hotspots

2.1 Hotspot 1 – Climate change and natural hazards

Introduction
Recent years have repeatedly witnessed natural disasters throughout the Alpine region. Examples include the exceptionally bad winter of 1999 and the catastrophic floods of 1999, 2002, 2005 – as well as 2007 in some areas. These events caused countless deaths and losses that ran into billions.
As studies in recent years indicate, climate change is already in progress. An increase in global temperature of 1.8 to 4°C by the end of the century is predicted. One consequence of climate change will be a decline in summer precipitation in the Alpine region, whereas winter rain will increase. Some degree of uncertainty is still attached to every climate model, especially where regional analysis is concerned. It is assumed that the general trend is correct, however. Furthermore it is assumed that changes to the north, south, east and west of the Alps will differ.

Even if we do not yet have scientific proof of the effect of climate change on natural hazards, we must nonetheless assume that natural disasters will occur more frequently and impact more heavily in the future than was the case in the past.

The Alpine region is, and has always been, a sensitive and to some extent weak system. Even small changes can have significant effects. Therefore, the extent to which climate change will influence natural hazards cannot be calculated precisely; only best guesses and trend estimates are possible.

The core problem arising from this situation is that the present degree of protection decreases and, with it, safety. This condition is brought about by the overload of existing safety constructions, or new and dangerous situations in which areas that have previously been considered safe are now under threat.

Principal objectives
The priority objective of a strategy to adapt to climate change must be to at least preserve the current level of residual risk and to take new and additional action on safety in terms of organization, planning and construction, as necessary. As in the past, particular attention must be paid to implementing solutions that achieve sustained success.

Possible strategies and measures
Essentially, there are only two possible strategies:
- Measures to influence the extent of damage (reducing potential damage)
- Measures to reduce danger (reducing potential danger)

The following catalogue of possible measures to reduce the risk caused by natural hazards is not given in order of priority.

Reducing potential damage

- Consistent development and adjustment of hazard maps as an important basis for adapted land use. These hazard maps must then be included in land use planning. Preserving threatened areas from any building development is still the best and most sustainable protection from natural hazards.
- If possible, improve early warning systems and perfect disaster operations, which can be put into action quickly and may help to improve safety generally.
- Maintain and check existing constructions to preserve their protective function and increase their degree of protection where appropriate to adjust to new situations. An overload capacity should be taken into consideration for new protective structures. Overloading should be considered and the residual risk estimated. If necessary, predefined discharges should be planned to check this loading scenario (including the impact of climate change). Predetermine several lines of defence.
- Provide the necessary human and financial resources. In this regard continuity is of special importance, even at "quiet" times.
- Implement robust and adaptable protective systems which do not suddenly collapse under excess loads. These must consider the possible risks caused by climate change.
- Integrate the public in a risk dialogue, particularly in terms of how to treat residual risks.
- Larger areas to conduct or retain water, sediment and driftwood are required; corridors must be kept free in case of extreme events.

Reducing potential danger

- Set up and continue natural hazard monitoring, e.g. measuring changes in the temperature of the permafrost. This may also include event documentation.
- Set up knowledge-sharing networks on regional, national and international levels that also highlight examples of best practice.
- Encourage individual responsibility on the part of those concerned, so that they take individual protective action or insure themselves against loss.
- Consistently practise compatible land use and, in particular, remediate protective forests.
- Examine ways to optimize the control of artificial reservoirs and natural lakes in line with local conditions to improve flood protection or low-water regulation.
- Uncertainties related to natural hazards are considerable. All opportunities to manage and minimize residual risks must be taken (e.g. property protection measures, emergency planning and insurance).
- Forecasting is vital, but only when time for action can be gained. Improvements are necessary to deal with the inherent uncertainties in regional forecasting and to improve its reliability.

Risk management and preventive action

Common preventive action to reduce risk can be grouped in to *non structural* and *structural* measures. The effectiveness of all measures depends heavily on precise knowledge of the territory and its dynamics, the ability to raise local awareness, and the quality and appropriateness of structural measures – not only as a factor of financial resources.

Objectives in dealing with natural hazards

The primary objective must be to maintain the Alps as a living and working space for people. The principles of integrated natural hazard risk management do not change even if we consider the worst possible climate scenarios. However, more attention must be paid to the aspect of management that involves thinking the unthinkable. We need solutions that at least maintain the current level of protection while at the same time, where necessary, reducing

residual risk with new protective organizational, planning and construction measures. Particular areas of focus here are a risk-based decision-making strategy, as well as the implementation of sustainable solutions.

2.2 Hotspot 2 – Risk dialogue

Introduction
Serious incidents have been the main factor in increasing awareness and prompting the adoption of measures concerning major industrial or natural hazards.

Disasters in all Alpine countries, such as the explosion on 4 January 1966 in France, the explosion at a chemical plant in 1974 in the United Kingdom and the 1976 accident in the dioxin plant in Seveso, Italy, threw into sharp relief the inadequacy of the safety measures that were in place. They led, for example, to the adoption in France of the Act of 19 July 1976, concerning installations classified on environmental protection grounds (ICPE). Certain industrial installations cannot be licensed without a preliminary public inquiry.

The European Seveso Directive of 24 June 1982 requires that states and companies identify the risks associated with certain industrial activities. It obliges the authorities to inform populations in the vicinity of high-risk industrial installations.

In April 1986, the accident at the Chernobyl nuclear power plant in the Ukraine, as well as a series of floods, led in several countries to open debate and to new organizational solutions for civil security, as well as in other areas such as the prevention of major hazards. In France, for example, Article 21 of the Act of 22 July 1987 gives citizens the right to information about the major technological and natural hazards to which they are exposed.

More recently, surveys in France revealed that half of the population living in areas prone to flooding were unaware of the situation.

Finally, the extremely important role played by the state and local authorities in risk management (prevention, protection and safeguard measures) in the past has contributed to a certain loss of a sense of personal responsibility on the part of the people themselves, who are either unaware of or simply neglect the individual steps that they themselves can take to enhance their safety and protect their property. The fact insurance companies in Alpine countries have increasingly taken responsibility - albeit to differing degrees - for the loss and damage caused by natural disasters has resulted in property owners increasing handing over their personal responsibility for loss and damage to the state and the insurance industry. This prompted France, for example, to restore the individual's central role in risk prevention with the 2004 Civil Security Act.

Society and politicians must be informed about the major risks
→ *Informing the people is one of the underlying principles of risk prevention.*

Risk awareness, familiarity with safety instructions and good preventive practices are essential factors in creating a climate of confidence, while minimizing the number of victims and the consequences of any damage. It is the foundation of efficient and effective prevention work.

Prevention work should enable people to find out about the dangers to which they are exposed, the foreseeable damage, the preventive measures they can take to reduce their vulnerability and the protection and rescue measures implemented by the public authorities. This is essential in helping people to overcome a feeling of insecurity and in creating a responsible attitude toward risks. It is also useful in building and maintaining an ongoing record of collective risks and, above all, a collective risk culture.

Risk communication as the basis of preventive work and a risk dialogue
In France, the information principle enshrined in the 1987 Act states that "all individuals are entitled to information about major natural and technological risks to which they are liable to be exposed in certain areas of the country, and about safeguard measures".

Risk communication with the public is built around two complementary approaches, *preventive information* and *preventive education*.

- *Preventive information* is the information that people are due as part of the effective management of major natural and technological risks.
- *Preventive education* is information on the prevention of major risks. This requires that safety training be incorporated into the teaching syllabus. It must cover the major risks and include the appropriate response for dealing with them. This training in risks and how to prevent them, particularly in the school environment, is a key element of the broader risk prevention system. By targeting a young audience, it also helps promote a "risk culture".

Requirements for maintaining a risk dialogue
Information about risk must include:

- The nature of the risk and its implications: location, description, consequences
- The steps taken to solve the problems with prevention work
- Safety instructions and the appropriate response.

Since levels of knowledge and recommended safety instructions can change over time, the information must be kept up to date.

To achieve a high quality of information, the following questions must be answered:

- What is the purpose of the information: general information, familiarisation with risk, location, appropriate response, to motivate people to do something, etc?
- Who makes up the target group for the information: individuals, general population, holidaymakers, decision-makers, elected officials, etc?
- Which institution will be responsible?
- Who will do the work?
- Who will disseminate the information, and what is the appropriate method?

French experience enables us to differentiate between the following:

a) An inventory and description of the phenomena and risk management plans within a territory
   For a regional or local territory, this involves identifying and mapping known or potential, technological or natural phenomena (flooding, landslips, forest fires, avalanches, etc.), their effects and the various risk management plans or regulatory measures implemented to prevent risk and ensure the safety of persons and property. The documents are public (freely available for consultation) and distributed to the stakeholders concerned.

b) Methods for informing the population
This involves making provision for and implementing various means of informing people in the exposed sectors. A number of options might be used: posters/signs, meetings, documentation, radio or TV messages, internet, and so on. Certain methods may become mandatory and systematic in certain situations. These would then be used to address the people, with no action required on their part. Other methods are available to the public who, in this case, are then required to take the initiative of seeking out the information. The various methods can be designed to complement each other.

c) Risk records
It is essential to keep track of known events that have occurred in the past.

2.3 Hotspot 3 – Residual risk

Introduction
Synoptic analysis of the question of residual risk on a continuum between risk acceptance and safety interests.
The actual magnitude of the "remainder" of a risk becomes apparent only when it becomes a reality.

The term "residual risk" has been in common use for some time, although its actual meaning is still elusive even upon closer scrutiny. The term is often used as a synonym for the uncertainty which remains as regards a hazard in spite of the safety precautions taken. In some cases it is interpreted as indicating that there is no such thing as absolute safety.
For lay persons, the term "hazard" is frequently taken to be identical with "risk", and safety and protection are mostly regarded as absolute quantities. However, it is largely unknown that risk has much to do with the acceptance and the assessment of a hazard. Given the lack of precision in the everyday language used to talk about natural hazards, an exact definition of terms is essential here.

Definitions
Residual risk is the risk which remains after all protective measures have been implemented. Protective measures reduce danger to an acceptable (reasonable) level. The decision as to what level of risk is acceptable depends on objective economic, social and ecological factors. Residual risk is closely related to the question of what level of risk is accepted by the individual or by society. Thus, residual risk is a function of the individual or collective acceptance of a risk and, consequently, difficult (if not impossible) to describe in mathematical or actuarial terms.

The technical residual risk is the risk which, in individual special cases, is scarcely predictable by calculations or statistical methods and which is due to the failure of protective structures or human error.

The following examples elucidate the difference between "technical risk" assessment and the psycho-social "acceptance of risk":
Incident 1: A minor accident, with 3 fatalities, for a period of 100 years
Incident 2: A major accident, with 300 fatalities, once in 100 years.
The risk would be exactly the same in both cases, but the acceptance of major accidents is generally lower (risk aversion).

Critical risk is the maximum acceptable risk attached to a certain technical process or condition. In general, critical risk cannot be expressed quantitatively either.

According to those definitions ….
…. safety is a state in which the risk is smaller than the critical risk.
…. hazard is a state in which the risk is greater than the critical risk.
Protection is the reduction of the risk by measures which lower the occurrence of damage in frequency or in extent, or both. Thus, safety and protection are not absolute but relative quantities.

Residual risk is composed of:
- Unknown (unpredictable) risks
- Unrecognized risks
- Consciously accepted risks
- Risks which are consciously taken
- Negligible risks
- Risks caused by inappropriate safety measures.

The term "residual risk" may be narrowed down conceptually by:
- Describing a "tolerable" risk as measured against current social values
- Laying down the accepted residual risk by formulating protection targets in political or technical terms:
  Examples: frequency and intensity of an event (WLV/Austrian Service for Avalanche and Torrent Control: HQ-150; BWV/Federal Water Engineering Administration: HQ-100); protection target graded according to the importance of properties (closed settlement areas deserve more protection than individual properties (Switzerland)
- Narrowing down the residual risk by the extent to which a person/society is willing to pay for having his/her/their safety interests met.

In summary, this demonstrates that the term "residual risk" is by no means unequivocal and may evoke different connotations depending on point of view. Thus, it is advisable to consider background when using this term.

Different points of view on residual risk

Legal dimension of residual risk

If "residual risk" is looked at from the technological point of view (e.g. frequency and intensity of endangerment in zones which are protected by defence structures), the focus shifts to the question of liability.
Important aspects in this context are
- The design and construction safety of the defensive structure
- Maintenance and safe operation of the installation.

Damage caused by natural hazards where no human is at fault (force majeure) falls within the sphere of risk of the aggrieved party in principle only. Cases in which the risk is shifted under the operation of law are pertinent only if natural conditions have been changed by human action. The increase in risk owing to the operational hazards attached to an industrial plant can be quoted as one example here. Depending on the specifics of those hazards, it may be impossible to plead force majeure.

The Austrian Supreme Court tends to admit a plea of force majeure in cases of catastrophic rainfall at intervals of more that 30 years.
Compensation for damages must be awarded as a matter of principle if the damage has been caused by unlawful and culpable action.
It is generally acknowledged that whoever has created a source of danger or has opened up a building/property etc. to traffic has a duty to implement safety precautions and ensure proper upkeep, including the responsibility to actively prevent damage which may be caused by others. The theory regarding the duty to implement safety precautions and guarantee the proper upkeep of buildings etc., ensures, in many cases, that the failure to take large-scale action to avert damage is deemed unlawful (and consequently liable for damages).[1]

Residual risk in land use and hazard zone planning
The boundaries between areas which are endangered by natural hazards and safe habitats are shifting. Owing to changes in natural areas (land use management, climate change), endangered zones are spreading steadily into areas used by man while, at the same time, growing demands in terms of affluence and quality of life are forcing urban areas to extend further and further into endangered zones. Hazard zones are created where zones endangered by natural hazards overlap with settlement areas. For example in Austria, dangers are mapped, depending on their severity, as red and yellow hazard zones.

Where residual risk is concerned, the function of the hazard zone map is reduced to a consideration of structural defence measures to determine the extent to which downstream residents are endangered.

Another question is whether an objective assessment of the residual risk is possible after protective measures have been implemented.

Even after permanent avalanche defence measures have been implemented, a residual risk still remains for the protected area in terms of:

- Overload (the avalanche event exceeds the design event)
- Avalanche release from an unprotected sub-basin
- Technical failure (material failure, structural faults, insufficient maintenance)
- Incorrect design basis
- Land use/building activities jeopardizing safety.

The fundamentals which would justify the demarcation of residual risk zones in the hazard zone map are largely non-existent for the risk factors which have been identified to reflect the effect of technical protection measures.
Clear assignment to an event with a certain recurrence interval (e.g. an event occurring once in 300 years) is usually impeded by the lack of sufficiently reliable data.
→ *The demarcation of hazard zones in protected areas should actually work against the increase in potential damage.*

[1] **Force majeure: an extraordinary event which does not occur or is not anticipated to occur at certain regular intervals and which can neither be avoided (not even by the exercise of all reasonable care), nor rendered harmless in its consequences; impacts from outside.**

Dealing with residual risks
The residual risk dimension depends on the quality of the available information. If we know the potential risk and potential damage, as well as how they interact, to a high degree of accuracy, we are in a better position to make a more reliable forecast of the type of impact an incident would have than if we had less accurate information. Residual risk may therefore appear smaller or greater, according to the available data. The same principle applies to forecasting the effectiveness of protective measures.
Natural disasters and their effects repeatedly highlight the permanent dilemma faced by the organizations charged with a preventive role:
Do we also have to think the unthinkable, and what consequences must we factor into our preventive work as a result of such considerations?

2.4 Hotspot 4 – Land use

Introduction
All the disasters in the Alpine space, as well as around the globe, and their consequences, are examples which show that land use (sometimes land abuse) is a key element in the growth of risk, at a certain level of hazard.
Basically, land uses depend on both geomorphologic – climatic and social – and economic characteristics of the land. The latter include its natural resources and local environmental, cultural and traditional heritage.
Land uses change over time according to shifts in the ability and will of the population to exploit or, better, "use", its land following – and sometimes inducing – changes in the aforementioned parameters.
The progress of economic activity and wealth has so far resulted in a tendency to expand into land traditionally used for farming or grazing. To slow down this trend, recent policies have focused on recovering areas which have already been developed, such as disused industrial sites and poor-quality constructions. The concentration of human activity and services (including infrastructures) in valley areas and increased population mobility are contributing to the abandonment of marginal mountain areas. These areas may nonetheless be favoured locally as tourist resorts, which in turn often means environmentally costly infrastructures.
Any environment – even outside the direct reach of man and protected through national and regional parks (high mountain slopes, glaciers, forests, etc.) – interacts with human territory and activities. In fact, the way land is maintained, and any change of use, has a significant impact not only on the space at the heart of such changes, but often much of the surrounding environment as well.
If we look at the changes across all regional territories (also including hill and flat areas), we see a marked increase in man-made areas and a decrease in farmed land. These changes obviously have a major impact on land management and on the distribution and level of risk.
Urban growth generally results in an increase in risk, by:
1. Occupying hazardous areas, hence increasing the value of exposed property
2. Helping to amplify the effects of hazard-generating phenomena, for example by reducing natural flood retention areas or by soil sealing.

Since a large body of evidence testifies to the relevance of the hydrogeological risk related to land use and land use changes in the Alpine space, it would seem appropriate to address this category of hazard, especially in the light of ongoing climatic change.

Strategies for appropriate land use management in respect of natural hazards

To reduce the harmful domino effects of land-use modifications, the most effective strategy would be based on a risk management plan which appropriately considers, and periodically monitors, all of the hazards and functions within a river basin or a system of interconnected river basins. The reconstruction stage also provides a fundamental opportunity to tune up structural and non-structural preventive measures and redefine land use where appropriate.

Mitigating the destructive effects of hydrogeological hazards: preventive measures

In general, the component of land management aimed at protecting humans and human activities from hydrogeological hazards makes use of a fundamental preventive tool which:

- Recognizes the territories potentially affected by such events and assesses their effects
- Identifies risk-prone areas, classified according to the level and type of risk
- Defines and implements an action plan to lessen, possibly neutralize, the most harmful effects of such events. The related measures may be a) non structural, i.e. impeding the increase in risk by forbidding new construction in hazard-prone areas; b) structural, i.e. engineering intervention to mitigate or eliminate risk. These structures may range from levees, retaining walls, etc. to the removal of structures that are particularly vulnerable or causing additional hazards (e.g. obstructing water flow).
  The effectiveness of this strategy depends heavily on its ability to influence, and possibly redefine, land use in the threatened areas.

Recognition of hydrogeological hazard-prone areas

Both deterministic and probabilistic methods are applied to evaluate the level of hazard in a given area. They are based on the knowledge provided by past events, forecasts of future meteorological input (basically, the amount of rain over a given time period, from hours to days), and some basic parameters about the territory, such as its morphology, lithology, permeability, and land cover. The latter parameters are to be treated as variables because of continuous changes in many catchment systems, from ski slopes to urban settlements, commercial compounds, factories, parking areas, bridges, roads, and even changes in forest management (maintenance, periodic felling, introduction of new tree species). They represent actual changes in land cover and morphology (buildings, landfills, roads, rectified river beds). They generally reduce permeability and the space available for flow paths, which are rigidly imposed. It should also be remembered that floods often originate upstream in the mountains, so that only an integrated approach that considers land changes over the whole system of sub-basins can predict future trends effectively.

Structural work and levees in particular are also an important change in land use which significantly alter fluvial dynamics locally and especially downstream. Identifying hydrogeological hazard-prone areas is therefore an extremely complex and never-ending task, requiring great attention to land use changes, both locally and up and down stream. Moreover, the probabilistic approach, which defines the recurrence interval of given rain/flow events based on the statistics provided by historical record, is flawed because there are clear climatic trends (changes), in addition to land use changes. As such, rather than occurring once a century, severe flooding might recur every ten years or so, or vice-versa. The easiest way to factor in such uncertainty is to base the model on longer intervals (more extreme events), which results either in large areas being excluded from land use changes, or in the building of ever-larger preventive structures.

Landslides are localized phenomena, but they may have dramatic effects downstream should they dam valleys to produce ephemeral basins, or fall occur within a basin, as in the Vajont disaster in 1963. Thus, land use is relevant not only above a landslide-prone area but also downstream. In such cases, drawing the boundaries of hazard areas becomes an even more difficult task.

Multi-function and coordination

Land use is a typical example of multi-functionality. The enormous and widespread changes in the use of the Alpine territory since the end of the 19th century mean that land is now used for a number of activities, many of which were previously unknown in the local area. These activities often have contrasting aims and requirements.

The conflict of contradictory interests in land use and the exploitation of resources common to different economic sectors (tourism and recreational activities, infrastructure networks including transport, energy, agriculture, forestry, and industry) is an obstacle to the integrated management of natural hazards. Instead, a concerted effort to create synergies between all of the sectors involved is essential to promote truly multi-functional intervention. These are aimed at, for example, stabilizing slopes in risk zones, reducing peak flow, regulating water resources, recovering abandoned territories, protecting/improving the landscape, creating nature reserves, establishing tourist/sport resorts, and building infrastructures (e.g. roads, railways, etc.).

To this end, considering that the financial resources allotted to hydrogeological risk mitigation are usually deficient, strategies aimed at obtaining an adequate flow of funds, either public and private, are necessary. As an example, in Italy the Basin Authority of the River Arno has defined a set of primary interventions for hydro safety that will interact and create synergies with other sectors that should contribute to their funding. Such works will include, for example, new and justified road connections along dikes bordering the flood retention plain, an international sports resort (rowing basin) within one of the flood retention areas, a reservoir, and an energy plant. Near the outlet, the extension and adaptation of a floodway, in addition to helping to mitigate the flood hazard in a large residential and industrial area, will also allow the transport of goods by boat, generating significant savings in terms of energy, emissions, road maintenance and safety.

Risk-based land use management: a major challenge for the Alpine region

The legislative and coordinative elements of land use planning lay the foundations for a use of space that is appropriate to the attendant level of risk. Only if risk-based land use management is driven forward jointly at national, regional and local levels, in collaboration with politicians, business and society, in a way that will develop its own momentum for the future, will it be possible to turn the potential damage generated by human interaction with natural hazards in to risk-based land use.

3 Conclusions for the future

3.1 Hotspot 1 – Adapting to climate change

1. Land use planning
Risk maps that plot natural disasters in the Alpine region must be factored in to spatial planning, in order to prevent further risk to the population in the future.

2. Knowledge-sharing, risk dialogue
Networks to share knowledge and experience at regional, national and international levels make a major contribution to knowledge transfer in the handling of natural hazards.

An appropriately focused risk dialogue that responds to society's needs can significantly reduce residual risk and damage.
Alongside all state and local authority endeavours, it is vital to effective risk management that acceptance and awareness of unavoidable risks from natural hazards are raised in order to stimulate a new approach to risk prevention that emphasises personal responsibility.

3. Monitoring, event documentation
Natural hazards in the Alpine region are caused by the interaction of complex processes that are often difficult to capture. Monitoring systems must therefore be set up – and maintained long-term – to improve our understanding of these processes. The consequences of climate change can already be seen today most strikingly in receding glaciers and thawing permafrost. Studies must nonetheless be extended to cover other areas such as flooding, mudslides, landslides and avalanches.

Event documentation and analysis is a very important element in this. We cannot draw conclusions about what may happen in the future if we do not understand what is happening now and why. Knowledge of the natural world and its relationships must be recorded and evaluated systematically to provide a foundation for this work.

4. Early warning, disaster management
Every effort must be made to improve early warning systems. Although this may be difficult because structures in the Alps are often small, every opportunity must be taken to improve early warning.

In combination with early warning systems, the emergency plans of the competent disaster defence authorities must be updated and optimised continuously in close collaboration with experts on natural hazards. The efficient use of defence forces can save lives and minimize damage.

5. Technical measures
Technical man-made defences will remain an essential part of risk management in the future. New structures, in particular, must be tested to establish the consequences of an overload. In some circumstances, predetermined breaking points may considerably reduce damage should the structure fail. Furthermore, structures should be as robust and adaptable as possible, without suddenly failing in the event of overload.

The maintenance of existing structures is a very important aspect of these technical defences. Man-made defences have been built in the Alpine region for some 150 years. They must continue to function and, were necessary, must be adapted to the present situation. This task will require major long-term funding in all Alpine countries.

6. Risk maps

Knowledge about events that have occurred in the past, as well as an analysis of at-risk areas from both the landscape and engineering perspectives, is indispensable in the prevention of natural hazards. Apart from hazards that are not specific to a particular area, such as hail, storm winds and earthquakes, most natural hazards such as flooding, mudslides, rock falls, landslides and avalanches are associated with specific localities.

Risk maps of natural disasters in the Alps provide a basis for consistent, risk-adjusted land usage and form an essential part of preventive action. The production and updating of hazard and risk maps form the basis of such action.

Mapping:

- The *management basin plan* is a cognitive and technical-operative tool to prevent hydro-geological risk. Its protective action is based on several basic components.
- H*azard maps* identify and classify hazard-prone areas.
- *Land use maps* give the information needed to identify and estimate exposed elements in the hazardous areas.
- The *risk map* is drawn overlapping the land use and hazard maps. It shows and classifies exposed property as a function of its risk level.
- Accurate and updated land use information provides detailed and reliable scenarios for elements to be protected, permitting adequate rules of land use to be drawn up.

7. Provision of resources

Political decision-makers must make the necessary human and financial resources available in the medium to long term in order to implement the measures that are needed. Taking the action that is required will cost more than EUR 1 billion per year throughout the Alpine region. We must take advantage of the quieter times between disasters, in particular. The next disaster will come – the only thing we do not know is when.

All in all, the task is to take the prevention strategies that are already being pursued to protect against natural hazards – those that were drawn up without factoring in climate change – and to implement them even more consistently on the basis of natural hazard risk management. Particular attention should be paid for the first time to climate change and the associated hazard potential.

3.2 Hotspot 2 - Risk dialogue

1. Informing and educating the population about major risks forms the basis of any steps taken to combat natural hazards

This may be undertaken for the following reasons:

- To improve local people's knowledge of the risks to which they are exposed and their consequences;
- To place the individual citizen at the heart of efforts to combat natural hazards; or
- In response to European directives on information.

Risk awareness, familiarity with safety instructions and good preventive practices are essential factors in creating a climate of confidence, while minimizing the number of victims and the consequences of any damage.

This kind of information is called "preventive". It should enable people to find out about the dangers to which they are exposed, the foreseeable damage, the preventive measures they can take to reduce their vulnerability and the protection and rescue measures implemented by the public authorities. This is essential in helping people to overcome a feeling of insecurity and in creating a responsible attitude toward risks.

Preventive information is also useful in building and maintaining an ongoing record of collective risks and, above all, a collective risk culture.

2. Information on risks is aimed at the entire population

In principle, all individuals are entitled to information about major natural and technological risks to which they are liable to be exposed in certain areas of the country, and about safeguard measures[2].

Depending on the aim of the risk dialogue, there are two possible approaches to raising the population's awareness of risks and possible preventive measures. These are as follows:

- *Preventive information* is the information that people are due as part of effective management of major natural and technological risks.
- *Preventive education* is education aimed at the prevention of major hazards. This requires that safety training be incorporated into the teaching syllabus. It must cover the major risks and include the appropriate response for dealing with them. This training in risks and how to prevent them, particularly in the school environment, is a key element of the broader risk prevention system. By targeting a young audience, it also helps promote a "risk culture".

These two approaches can be used separately or in combination as part of a targeted risk communication plan. Informing the public needs to be based on two complementary approaches: preventive information and preventive education.

[2] Wording based on French legislation

3. The information must be complete, comprehensible and organized
Information about risk must be exhaustive and must include:

- The nature of the risks: description, consequences, location, etc.
- The steps taken to combat the risks
- Safety instructions and the appropriate response.

Since levels of knowledge and recommended safety instructions can change over time, the information must be kept up to date.

The following questions must also be answered:

- What is the purpose of the information: general information, familiarization with risk, location, appropriate response, etc?
- Who makes up the target group for the information: individuals, general population, holidaymakers, decision-makers, elected officials, etc?
- Who is responsible for drafting and disseminating the information: the state (central or local government), the community (e.g. village), individuals, etc?
- How will the information be disseminated: posters/signs, leaflets, the media, languages, internet, etc?
- To increase efficiency, it is important to try to harmonize the different objectives, targets and dissemination methods.

French experience enables us to differentiate between the following:

- An inventory and description of the phenomena and risk management plans within a territory;
- Methods for informing the local population: posters/notices giving information and instructions about hazards, regular communication campaigns, improved cooperation when drawing up prevention plans, access to information online, etc.
- Maintaining risk memory: setting up flood markers, obtaining information from owners and tenants of a property regarding current risks and previous incidents
- Preparation and dissemination of weather bulletins (floods, storms and gales, avalanches), before and during an alert
- Training pupils in school.

Responsibility for this information falls primarily to the public authority – central or local – which holds the information and whose job it is to protect the population. When competencies are split between different bodies, the precise role of each must be clarified. The mayor is one central figure, but the state and the individual citizen also have their roles to play in the information system. Preventive education should feature on the school syllabus.

3.3 Hotspot 3 – How to deal with residual risk

Recommendations on how to deal with residual risk primarily in flood protection

The floods of August 2002 demonstrated that there are natural phenomena that defy belief, and that the forces of nature are able to destroy man-made buildings in spite of all efforts undertaken to protect them. This means that there is no absolute protection. If this cannot be achieved, the goals which are realistic in flood prevention have to be defined. These include,

above all, the protection of human lives and means of subsistence, the protection of bodies of water, the mitigation of material damage, ensuring rebuilding and enabling people to start again from scratch, as well as the sustainability of the related measures.
To achieve these goals and to mitigate the damage as far as possible in case of future major flood events, a wide range of action is required:

1. Point out the limits to protection as well as the responsibilities of all parties involved. These must be made clear. Only if there is a willingness to cooperate will it be possible to cope with damage in a way that is in the interests of the community as a whole. Flood protection is an issue which concerns everyone.
2. Promote knowledge about and awareness of dangers: this means recognizing danger and neither forgetting nor suppressing this knowledge, and taking it into account accordingly in all actions.
3. Safeguard changing land use by means of spatial planning: the use of land must be adjusted to the circumstances prevailing at the site and not vice versa. Flood plains should be available as retention areas, which often goes hand in hand with an improvement in the ecology of the riparian landscape.
4. Encourage incentive systems for personal responsibility. In principle, everyone is responsible for protecting his or her own property, thus everyone can be expected to contribute individually to flood prevention. Much could be achieved here by sound information and appropriate incentives, if necessary. These need not even be very costly.
5. Recognize flood-relevant, negative developments: insidious developments are recognized as a problem only when the trend can be reversed only with great difficulty from a technological point of view or hardly at all from an economic point of view. By taking process-oriented preventive action, the situation may be corrected before it is too late.
6. Coordinate all planning activities undertaken by the public authorities: many conflicts of interest can be avoided by coordinating all the relevant planning activities, with the federal and regional agencies setting an example.
7. Protective measures where necessary: defence structures will fulfil their function of protecting existing settlements only if they are properly maintained and examined for their effectiveness and updated on a regular basis.
8. Provide for emergency planning and disaster prevention measures: just as fire protection cannot replace the fire brigade, defence structures are not able to replace emergency planning. Flood protection measures, no matter how comprehensive, can never guarantee absolute safety. It will always be necessary to complement their effectiveness by emergency planning and disaster prevention measures.
9. Financial provision, insurance and settlement of claims: just as nature cannot protect itself from the event, but takes all possible precautions to ensure fast regeneration, humans must ensure that they are able make a new start through savings, insurance and private or public assistance after the event.

The principle for dealing with the problem of residual risk in an integrated natural hazard risk management process is basically independent of the type of processes involved. When making comparisons, however, it must be remembered that the quality of knowledge about individual hazard processes differs widely. For example, there is less uncertainty attached to the residual risks associated with avalanche hazards than is the case with mudslides.

3.4 Hotspot 4 - Land use

1. Land use management

To allow sustainable territorial development, land administrations need planning tools that define rules at the local, regional and interregional levels for sustainable urban and industrial development, the exploitation and protection of natural resources and cultural heritage, and the safety of people and property from natural and man-made hazards.

Management plans, which are the common tool of land management, must always take into account different needs and must strive to establish the most appropriate land uses for a given territory. In reality, economic and social forces often push urban development on the one hand, while on the other, increasing attention is being paid to the protection of the environment and especially of the wilderness. These areas are now seen as part of the wealth of common heritage, and are often able to offer growth and wealth to local communities in many Alpine regions, without the disadvantages of industry or invasive tourist resorts – provided they are appropriately preserved or recovered where degradation has occurred in the past. In any event, a complex dynamic balance must always be sought between economic development and safeguarding ecosystems.

Thus, in general, planning strategies must analyse in detail the natural trend in the territory and select those uses which best permit its "exploitation", considering that, sometimes, the best use is non-use! The latter conclusion might be based not only on the will to protect particularly valuable environments, but also on a hazard perspective and the related potential risks and costs of their reduction, both environmental and economic.

2. Land use priorities

Land management should defend and, at the same time, improve the value of environmental resources. It should also avoid significant impacts on local economic growth.

The safeguarding of people and man-made structures, without overlooking environmental and cultural sites threatened by natural and man-made hazards, must be given the highest priority, with urban and infrastructural planning forced to adapt to such needs. In the future, the coordination of priorities in land use management must be discussed more and more on an interregional level.

3. Compensation and involvement

Very often, land management plans face opposition from local communities, essentially because of:

- Unsatisfactory compensation for the disadvantages to the community that is subject to specific works or restrictions
- The lack of – or even non-existent – involvement of local communities in the development process for the plans. This creates confusion and even open mistrust about new works or restrictions (even when they have a sound scientific and technical value). This often leads to strong opposition.

4. Measures

Hazard maps must be drawn up quickly so that hazardous areas can be avoided or, if they are already used, so that their use can be adjusted to the prevailing risk. It is essential that a potential damage map be drawn up assess the attendant risks.

4 Recommendations

In conclusion, it must be stated that the population, buildings and important infrastructure facilities can be protected effectively only if the authorities, owners, insurance companies and the population enter into a risk dialogue that targets existing natural risks and derives a plan of action. In drawing up this action plan, a comprehensive solution should be chosen that allows ongoing protection from natural hazards. Within the scope of the Alpine Convention, governments are required to give the following measures top priority:

Target

Safety is a fundamental condition for the development of the Alpine Space and its sustainable development. We should guarantee the same safety for everyone living in the Alpine Space.

Mitigation

- Reduce the burden on the environment by acting in a sustainable way. Treat non-renewable and limited resources with care.
- Ensure the long-term provision of the resources needed for integrated, holistic natural hazard management.

Adaptation

- Promote and support integrated risk management that fully exploits the potential of possible protective measures in a coordinated way. These protective measures include prevention (land use planning, care of protective forests, early warning systems, renaturalisation of waterways, protective structures) and disaster management (intervention), repair and rebuilding.
- Considering the increasing frequency and intensity of events, it is vital that existing and planned protective measures be reviewed in terms of the conceivable overloading of protective structures. Particular attention must be paid to the maintenance of protective facilities.
- Targeted, consistent risk dialogue with all of the parties involved in order to strengthen prevention efforts and promote risk-consciousness and the acceptance among the public of risk-appropriate action. Monitoring systems must be set up to keep risk situations under observation. These systems offer an important means of communicating risk.
- Promote knowledge to ensure risk-appropriate land use via targeted training.
- Promote and support the early recognition of potential hazards that are caused or influenced by climate change, such as avalanches, flooding, mudslide and landslide hazards.
- Finally, a flyer should be created to draw the attention of those organisations and local authorities that are ultimately responsible for protection against natural hazards to the need for a risk dialogue about climate change and natural hazards.

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