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NATURAL HAZARD RISK GOVERNANCE

Report on the state of the Alps

ALPINE CONVENTION
Alpine Signals – Special Edition 7

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FOREWORDS

The Alps affect the lives of people in our region – and vice versa. This mountain range in the heart of Europe is facing substantial social and structural changes, ranging from demographic change to urbanisation, to topics such as migration and transit. One aspect where the interaction between mankind and nature is particularly at stake is climate change. The Alps are amongst the regions that will be most influenced by the rapid climate changes.

The consequences of global climate change are clearly perceived. In 2018 many natural disasters occurred in the Alps, for instance the flooding catastrophe in the valley of the Saalach river in Salzburg or the hurricane Vaia in Carinthia and Eastern Tyrol. It is therefore pivotal that the people living in endangered areas can prepare and respond in the best possible way to the additional risks. We must develop sustainable solutions together and be determined to implement them.

Natural hazards affect us all. For a successful risk prevention, politics and the people need to work closely together – from careful security planning to highly efficient protective measures. The Alpine people have a long-standing experience in managing natural hazards. The affected countries and regions have a variety of protective mechanisms at their disposal as well as extensive know-how, which has grown with time. Transnational processes such as the Alpine Convention offer possibilities for joint discussions on the proposed solutions and for the exchange of established methods.

The Natural Hazards Platform of the Alpine Convention (PLANALP) is dealing with protection against natural hazards since 2004 and it is constantly discussing all current strategic questions. Renowned experts exchange views on protecting people and infrastructure, they discuss new trends and coordinate common activities in the Alpine area. This way they are strengthening national strategies and promoting the whole Alpine space as a pioneer in the management of natural hazards.

I am particularly pleased that the seventh Report on the State of the Alps on the topic of "Natural hazard risk governance" was prepared under the Austrian presidency of the Platform Natural Hazards following the motto "Protect and utilise". This text is a milestone, for the first time summarising in one report the knowledge of the Alpine countries.

Many concepts of risk prevention can be transferred to other regions too. Natural hazards know no administrative boundaries – hence I am deeply convinced that only together we can successfully tackle future challenges. The Alps are an important environment for life and for the economy: let's make sure they remain a model for the future!

Elisabeth Köstinger
Federal Minister for Sustainability and Tourism, Austria

Ever since humans have started settling in the Alps, they needed to cope with the natural hazards emanating from this mountain environment. There is a logical sequence starting from the hazards themselves and the risk they pose, to measures addressing them, to finally the question of how we organize our responses to such risks. In other words, which approach we take for natural hazard risk governance. This theme goes at the core of two essential aspects in the lives of Alpine people: their safety and their participation in choices that affect them. Risk governance fills the gap between humans and nature by bringing together physical and societal issues, it stresses the need to reconcile the call for safety with democratic and participatory principles, in order to find a balance amongst colliding interests on a territory.

Given its morphology, less than one fifth of the territory within the Alpine Convention perimeter is suitable for settlements and therefore most human activities are concentrated in valleys, often densely populated, where natural disasters can cause considerable damage. But the damage potential is high also in more rural areas, particularly if they are used intensively for tourism. Moreover, risk and hazard evolve dynamically, especially because of changing climate conditions: this may exacerbate the intensity of hazards and contribute to a shift in hazards-prone areas.

The protection against natural hazards requires thus strong decisions that affect people's security and sometimes their lives. Establishing an ongoing dialogue with the local populations and increasing their participation in such decisions brings about benefits not only in terms of democracy and inclusiveness: it also strengthens the feeling of ownership of the people on their territory, their responsibility and awareness about the consequences and the appropriate response to natural hazards, as well as increasing the effectiveness of the measures, thanks to the contribution their long standing knowledge and experiences on hazards bring into the definition of the measures.

Natural hazard risk governance is therefore a topic at the crossroad of protection and inclusiveness, safety and democratic principles. It allows us to highlight the importance of achieving effective protection results while broadening participation in decision-making. This topic also enables us to evaluate the challenges of this process, to identify solutions and strategies, to base our efforts on facts, existing knowledge and successful examples.

The seventh Report on the State of the Alps tries to achieve all this. It reflects the importance that the Alpine Convention attaches to the liveability and safety in the Alps, and on inclusive processes that allow for the needs of different stakeholders to be taken into consideration. Researching, discussing, drafting and disseminating the outcomes of such an in-depth analysis can significantly contribute to raise awareness, to identify new solutions and innovative, effective and shared procedures.

The knowledge and the experiences of the members of PLANALP have allowed the production of this Report that takes a broad, Alp-wide approach to the governance of risk: Alpine countries need to constantly improve their procedures of natural hazard risk governance, to enhance resilience and participation, mitigation and ownership. We need to continue to implement joint, coordinated efforts to protect residents and improve the living conditions in the Alpine region for all.

I wish to thank all who have contributed to this report!

Ambassador Markus Reiterer
Secretary General of the Alpine Convention

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ABBREVIATIONS

AC	Alpine Convention
AINEVA	Inter-regional Association of Snow and Avalanche Warning Services *(Associazione interregionale di coordinamento e documentazione per i problemi inerenti alla neve e alle valanghe)*
APSFR	Areas of Potential Significant Flood Risk
CLV	Local Avalanche Committee *(Commissione Locale Valanghe)*
CMI	Joint Flood Commission *(Commission Mixte Inondation)*
DDT	Departmental Land Use Direction *(Direction Départmentale des Territoires)*
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DWA	German Association for Water, Wastewater and Waste *(Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall)*
EAFRD	European Agricultural Fund for Rural Development
ECHO	European Commission's Humanitarian Aid and Civil Protection Department
ERDF	European Regional Development Fund
EU	European Union
EUSALP	European Union Strategy for the Alpine Region
FMS	Foundation "Montagna Sicura" *(Fondazione Montagna Sicura)*
FPRNM	Fund for the Prevention of Major Natural Hazards *(Fonds de Prévention des Risques Naturels Majeurs)*
FRMP	Flood Risk Management Plan
HQ	Flood line (in connection with frequencies of design events, *Hochwasserquote*)
INGV	National Institute of Geophysics and Vulcanology *(Istituto Nazionale di Geofisica e Vulcanologia)*
INSPIRE	Infrastructure for spatial information in Europe
IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
ISPRA	Institute for Environmental Protection and Research *(Istituto Superiore per la Protezione e la Ricerca Ambientale)*
LAINAT	Steering Committee for the Intervention on Natural Hazards *(Lenkungsausschuss Intervention Naturgefahren)*
MDG	Millennium Development Goals
MSP	Municipal Spatial Plan
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
OWARNA	Optimisation of Early Warning and Alerting of Natural Hazards *(Optimierung von Warnung und Alarmierung bei Naturgefahren)*
PAPI	Action Programme for flood prevention *(Programme d'Action de Prévention des Inondations)*
PAV	Avalanche Management Activity Plan *(Piano delle Attività in Materia Valanghiva)*
PFRA	Preliminary Flood Risk Assessment
PLANALP	Natural Hazards Platform of the Alpine Convention
PPRN	Natural Hazard Risk Prevention Plan *(Plan de Prévention des Risques Naturels)*
PSR	Flash Floods Plan *(Plan de submersions rapides)*
RSA	Report on the State of the Alps
SAFPA	PAPI and PSR Administrative and Financial Monitoring *(Suivi Administratif et Financier des PAPI et PSR)*
SDG	Sustainable Development Goal
SFDRR	Sendai Framework for Disaster Risk Reduction
SIC	Spatial Implementation Conditions
SLF	Snow and Avalanche Research Institute *(Institut für Schnee- und Lawinenforschung)*
TRI	Significant Flood Risk Area *(Territoires à risques importants d'inondation)*
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations Office for Disaster Risk Reduction

EXECUTIVE SUMMARY

Natural hazards pose a constant threat to our living environment and to human life. Alpine areas are particularly prone to a number of hazards, such as river floods, avalanches, rockfalls, debris flows and landslides. With the development of modern democratic states, hazard management as a state responsibility was based on a legal foundation. The various authorities in charge have since then been struggling to ensure and maintain the adequate safety of people, to protect infrastructure and in general to reduce risks. Natural hazards limit spatial development and need to be considered accordingly. The way hazards are managed is changing. There are changes in institutional capacities, climate conditions and in the involvement of concerned people. Exclusively state-led planning, financing and implementation mechanisms for hazard prevention are gradually being complemented by inclusive processes that involve the public and take natural hazard risk into account.

The Alpine Convention (AC) is an international treaty between its member states (Austria, France, Germany, Italy, Liechtenstein, Monaco, Slovenia and Switzerland) and the European Union (EU) that aims to foster sustainable development and protection of the Alps. To actively contribute to current discussions on the ecological, economic and social development of the Alps, the Alpine Convention periodically publishes a Report on the State of the Alps (RSA). For the 7th report, the Natural hazards platform of the Alpine Convention (PLANALP) has prepared this status quo analysis along with recommendations for enhancing risk governance to examine current changes in the way society handles natural hazards.

The report provides an overview on the risk governance concept and its relevance for the Alpine Convention member states. The overview is followed by an analysis of how risk governance is applied to existing management systems. To illustrate different forms of potential governance mechanisms, good practice examples from the entire Alpine Convention perimeter are included in the report. Although risk governance is a general concept, this report exclusively applies it to specific phenomena, i.e. floods, avalanches, torrential hazards, rockfalls and landslides.

The report concludes with the following recommendations for enhancing natural hazard risk governance:

- promote risk governance as a concept to enhance risk management;
- use risk governance to develop integrated measures for hazard prevention;
- integrate local initiatives in developing solutions for managing natural hazard risks;
- provide financial and other incentives to include and consider participatory approaches in various steps of developing protection and prevention systems;
- apply risk governance in a practical and professional way.

Natural hazards are closely linked to climate change. Especially in the Alps, changing hazard areas also create new challenges for effectively handling natural hazard risks. Adaptive behaviours and strategies are essential. Professional risk governance can help to foster mitigation and adaptation on different levels. This is also outlined in several national and transnational strategies on climate change adaptation.[1]

The expert discussions and the data for this report were provided by the PLANALP platform in close cooperation with the Action Group 8 of the European Union Strategy for the Alpine Region (EUSALP), responsible for mapping natural hazard risk governance.

1. *E.g. the EU Adaptation Strategy. Further information: ec.europa.eu/clima/policies/adaptation/what_en.*

TERMS AND DEFINITIONS

The following terms and definitions represent a specific understanding that is only valid for this report.

EXPOSURE
People, property, systems or other elements present in hazard zones that are thereby subject to potential losses.

GOVERNANCE
A complementary approach to government-based public administration schemes and legal frameworks. It relates to the process of interaction and decision-making among actors involved in a collective problem.

HAZARD PREVENTION
Hazard prevention in this report indicates the various possibilities to either prevent natural hazards from occurring or mitigate their possible effects on people, settlements, infrastructure, etc.

NATURAL HAZARD
Natural process or phenomenon that may cause loss of life, injury or other health impacts, as well as property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.[2]

NATURAL HAZARD RISKS
Terminology to point out, that the risk concept is applied to the relevant natural hazards for this report.

RESIDUAL RISK
A risk that remains after adopting protection and prevention measures and for which emergency response and recovery capacities must be in place. Residual risk includes unidentified risk, unknown risk and deliberately accepted risk.

RESILIENCE
The ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, also through the preservation and restoration of its essential basic structures and functions.

RISK
Risk is a combination of the consequences of an (hazard) event and the associated likelihood/probability of its occurrence. In a simplified understanding, risk is the product of hazard probabilities and damage potential.

RISK GOVERNANCE
The various ways in which all interested subjects manage their common risk affairs.[3]

RISK MANAGEMENT
A concept that can be outlined with three simple questions. What are the potential hazards? What risk are we willing to take? Which measures of the integrated risk management cycle (see Figure 11) should we adopt? This idea follows the approach to take into account the effects and damages of natural hazards while defining accepted risk as well as mitigation and adaptation measures.

The term risk management is used throughout the report, incorporating the terms natural hazard protection and natural hazard management as certain perspectives.

VULNERABILITY
The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

2. *EC, 2010.*

3. *De Marchi, 2015.*

1. INTRODUCTION

Natural hazards pose a considerable threat to settlements, infrastructure, livelihoods and human lives. Public authorities are administering various programmes, projects, funds, etc., to increase the safety of people and reduce risks. Sophisticated regulatory frameworks have been developed primarily on national and regional levels to guarantee an adequately safe living environment. Nevertheless, well established sectoral administration schemes reach their limits when it comes to public participation and the integration of non-governmental stakeholders. Over the past decade, an active discussion and comprehensive research[4] on hazard management have been conducted to improve collaboration and align procedures among public authorities, to achieve a shift towards a more integrated hazard management concept, and to increasingly incorporate the concept of risk (risk management).

The present discussion on risk management acknowledges the limitations of a rather exclusive focus on public authorities and the necessity to consider a broader set of stakeholders. First, risk-based decision-making is gaining importance and is increasingly accepted as a way to foster cost-efficient solutions. Second, local people, communities, municipalities and non-governmental organisations (NGOs) are increasingly included in developing integrated measures to avoid and reduce risks. A status quo analysis on risk governance is provided in this report.

For a long time, natural hazards were almost exclusively addressed with technical protection measures and managed by state institutions. Reality revealed that a simplistic understanding of natural hazards and individual countermeasures were not sufficient. Holistic perspectives are needed to include all relevant aspects of preparedness, response and recovery from natural hazards. Legal frameworks have been improved to widen perspectives, but natural hazard management itself is still dominated by the state. However, participatory planning processes, self-protection and shared responsibilities among the concerned population are gaining momentum. The Alps are on the brink of moving from the confines of hazard management to a more holistic **risk governance** approach. This concept aims to foster cooperation and coordination among official stakeholders and concerned parties sharing the same risks. Responsibilities should be borne together, and a participatory approach with commonly developed measures can help to raise awareness and find innovative and well accepted solutions. Natural hazard risk governance might still be in an early stage, but it is evolving quickly, as the good practice examples from all over the Alps show. The current Report on the State of the Alps provides insights into these changes.

After the catastrophic avalanche and flooding events in 1999 and 2002, the Alpine Convention established the Natural Hazards Platform (PLANALP) in 2004. The idea was to develop common strategies to prevent natural hazards in the Alps and to foster an exchange on adaptation strategies. Later, the focus shifted from hazard management to risk management, since addressing only the hazards is not sufficient. This change is still under way. At the same time, governance is becoming more important, so we are seeing two concurrent and overlapping developments.

During the Austrian Alpine Convention presidency 2017-2018, PLANALP took over the responsibility for preparing the 7th Report on the State of the Alps with a special focus on natural hazard risk governance. The report was prepared in close collaboration with EUSALP Action Group 8, which is also working on a governance mapping for natural hazards management and has provided a broad spectrum of valuable contributions. Nevertheless, this report focuses on the discussion of only a few hazard processes: floods, avalanches, torrential hazards, rockfalls and landslides.

4. *Specific funding programmes by the European Union like the Alpine Space programme help to carry out research and cooperative activities. Further information: www.alpine-space.eu.*

NATURAL HAZARDS AND MULTI HAZARDS

The Alps face a variety of natural hazards with different scopes including local events such as avalanches, rockfalls, torrential hazards and landslides as well as larger events like **floods**. **Earthquakes**, **storms**, **freezing rain** or **forest fires** – just to list a few – also pose a severe threat to settlements, technical infrastructure and even to protective structures such as protective forests.

A single site can be threatened by various natural hazards and therefore face so-called **multi-hazards**.

Figure 1: Freezing rain in Slovenia (©Administration of the Republic of Slovenia for Civil Protection and Disaster Relief)

1.1 GOVERNANCE AND RISK

To set the scene, this chapter will describe the essential terms and concepts for this report. The term *governance* for instance seems to be omnipresent in political discussions across various sectors. In the international context of natural hazards, governance is a more recently established term. Society is challenged by the complexity of social, economic and environmental problems that cannot be met with hierarchical procedures of public administration. The plurality of competing interests and preferences requires coordination and cooperative policy-making across different institutions and territories.[5] This network of various relevant actors and stakeholders is essential to the governance concept. In this understanding, the construction of policy networks and collaborative relations is an important addition to existing formal procedures. Governance is a complementary approach to government-based public administration schemes and legal frameworks, and it tries to compensate certain limitations. Decisions should be taken not so much in administrative and territorial dimensions: the participation of different stakeholders should be fostered and decision-making should rely on a negotiation process rather than on formal modes only.[6]

Governance can therefore be described by attributes such as network-like, non-hierarchical, flexible and boundary-spanning. This may sound very abstract but simply means to think out of the box and not just limit solution-finding to formal procedures. Public institutions usually maintain an important role. They need to set the framework conditions and define accredited actors and aims of governance processes. They also hold other legally defined responsibilities such as organising, facilitating and monitoring the implementation of decisions.

The possible applications of the governance concept are manifold. Apart from the theoretical discussion, they are actively put to the test in connection with different state responsibilities. Governance is often perceived as a conflict resolution strategy but is really most effective as a proactive approach to develop integrated and accepted solutions for issues such as dealing with natural hazard risks.

The term *risk* is also omnipresent in the discussion on natural hazards. In a well-established but simplistic understanding, risk is the product of hazard probabilities and damage potential. However, the risk concept is also used in many other fields and backed by profound research. Therein, risk is described with further attributes such as complex, uncertain and ambiguous in a holistic theoretical understanding.[7]

In this report, the risk concept is linked to governance mechanisms that look into the procedural aspects of dealing with natural hazards.

5. *Benz and Papadopoulos, 2006.*
6. *Benz and Papadopoulos, 2006.*
7. *Renn et al., 2011.*

RISK MANAGEMENT

Risk management in this report is not just used as a vague term but rather as a concept that can be outlined with three simple questions.

What are the potential hazards? What risk are we willing to take? Which measures should we adopt?

This idea follows the approach to take into account the effects and damages of natural hazards while defining accepted risk as well as the avoidance, reduction and adaptation measures.

A certain **residual risk** always persists concerning the unexpected and unlikely because it is impossible to provide 100% safety and avoid natural hazards or their impacts completely. Residual risk can therefore be understood as the risk that remains after adopting protection and prevention measures and for which emergency response and recovery capacities must be in place. Residual risk includes unidentified risk, unknown risk as well as deliberately accepted risk.

A generally growing population and accumulation of human assets and settlements in hazard-prone areas as well as extreme events tend to increase natural hazard risks. **Residual risk and cases of overload** therefore need to be considered. A recent study within the EUSALP Action Group 8 provides recommendations and good practice examples for both policy- and decision-makers.[8]

1.2 RISK GOVERNANCE FOR NATURAL HAZARDS

As the introduction on governance shows, the understanding of risk governance is clearly based on an extensive international exchange of ideas and perspectives in the scientific discussion. There is no universal definition of the concept. When it comes to natural hazards, the actual threat is experienced directly by the affected population. Consequently, past events shape the common memory and risk awareness and therefore strongly affect local people and communities. A definition by De Marchi takes up this idea and states that risk governance "can be described as the various ways in which all interested subjects manage their common risk affairs"[9]. This definition is simplistic but states the essential two parameters for risk governance: a common problem of concerned stakeholders (local population, public authorities, NGOs, etc.) and the existence of a discussion and negotiation network that helps to deal with natural hazard risks.

The scientific and political discussion on risk governance does not only take place in sectoral perspectives but also at different spatial and administrative levels.

In the international discussion, the Council of the Organisation for Economic Co-operation and Development (OECD) published recommendations on the governance of critical risks, stating that "members establish and promote a comprehensive, all-hazards and transboundary approach to country risk governance to serve as the foundation for enhancing national resilience and responsiveness"[10]. To achieve this goal, national strategies should be adopted, and leadership at national level has to be assigned. Partnerships with the private sector and civil society should be established, and the awareness of critical risks needs to be raised to mobilise households, businesses and international stakeholders to foster investments in risk prevention and mitigation.[11] This approach still represents a state-centred perspective and assigns the responsibilities to promote a shift from hazard management towards risk governance.

The scientific discussion on risk governance is highly diverse. In this report, governance is understood as the multitude of actors and processes that negotiate collectively binding decisions. Risk governance applies this principle to risk-related policy and decision-making and can have various results, such as the establishment of a cooperative to finance protection measures. Risk governance does not just let people participate but empowers them to take over responsibilities for themselves and develop solutions for hazard prevention in a dialogue with different stakeholders.[12]

Risk governance can be distinguished from the well-established broad and inclusive concept of disaster risk

8 *Eurac Research, 2018.*
9. *De Marchi, 2015.*
10. *OECD, 2014.*
11. *OECD, 2014.*
12. *Link & Stötter, 2015.*

management (DRM) in various aspects. First and foremost, disaster has a wider scope than hazard, putting a stronger focus on resilience. DRM uses a risk understanding composed of vulnerability[13], exposure[14] and the hazard process (see Figure 2).

Figure 2: Risk components in disaster risk management (Source: UN-SPIDER, 2018, adaptation)

Establishing risk as a basis for decision-making in natural hazard management goes beyond national efforts. The Floods Directive[15] of the European Union, for example, is an important integrated flood management approach that emphasises the communication and information aspects of risk governance. Referring to the definition given above, risk governance for natural hazards can be understood as the various ways in which all interested subjects manage their common risks posed by natural hazards. Risk governance is perceived as a useful tool to increase resilience on an individual as well as a general level.

Risk governance for natural hazards as such is not mentioned directly in the legal documents of the Alpine Convention. Nevertheless, the ongoing international exchange and collaboration to handle the risks related to natural hazards is of utmost concern to the Convention.

Figure 3 illustrates in a simplified manner how natural hazard management has evolved over time. Historically, dealing with hazards primarily meant living with hazards and then slowly developing a system for hazard protection. Based on experience and observations, individual measures were implemented, and the locations for settlements were chosen accordingly. In the 20th century, hazard management emerged with the formulation of a legal framework, installing the state as the responsible authority. Hazard management was enhanced over time and integrated perspectives to foster common and coordinated actions of different authorities.[16] The next development step in Europe was closely related to the EU Floods Directive, which established risk as an essential basis for planning prevention measures. Risk management became the prevalent approach. It not only uses exposure and hazard areas as a basis for decision-making but also takes vulnerabilities into account. The concept nowadays is actively applied and also raises awareness regarding the complexity of the processes. Risk governance is a further step up in how we deal with natural hazards, where many actors with a common problem or risk negotiate solutions on different spatial levels. To enable such a development, changes and amendments in regulatory frameworks might be necessary to varying extents. However, risk governance can also be implemented within the existing frameworks already.

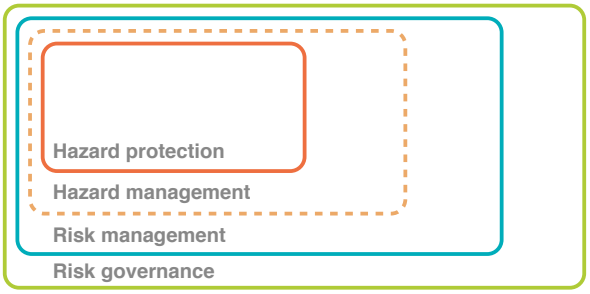


Figure 3: Development of natural hazard and risk management (Author: Schindelegger, 2018)

The development phases of dealing with natural hazards can also be presented with the cycle of integrated risk management (see chapter 2) and the three phases of preparedness, response and recovery. Living with hazards, i.e. having no management schemes in place, incorporates only the element of recovery and avoidance. Hazard protection already includes the preparatory aspects of avoidance and a certain degree of protection. Hazard management and risk management go one step further and use profound and complex analysis to devise and coordinate prevention strategies and measures. Hazard management uses a rather simplistic understanding of the impacts of hazard events (hazard + exposure), while risk management also takes vulnerability into account. Risk governance develops the risk cycle with its phases even further and draws attention to the boundary conditions (framework, actors, resources) and processes (participation, dialogue, etc.).

13. *The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard (EC, 2010).*
14. *People, property, systems or other elements present in hazard zones that are thereby subject to potential losses (EC, 2010).*
15. *Directive 2007/60/EC.*
16. *Stötter & Fuchs, 2006.*

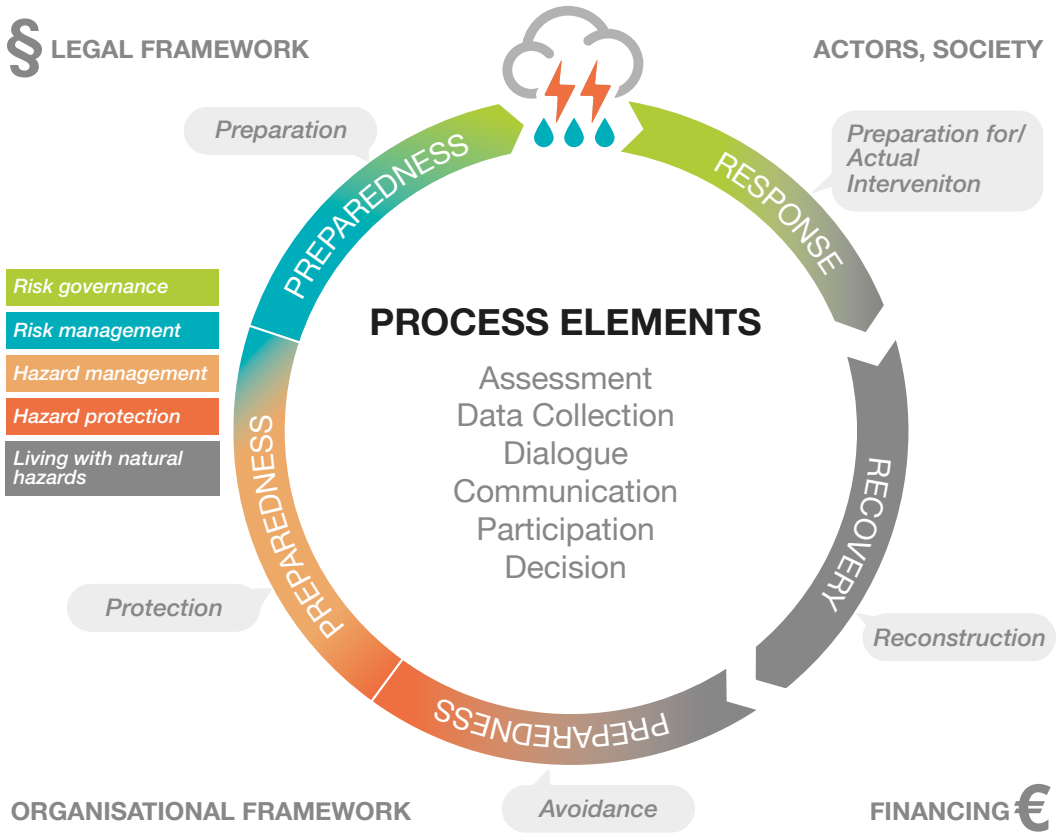


Figure 4: Development of the management and governance concept in the cycle of integrated risk management (Author: Rimböck, Schindelegger, 2018)

Today, initiatives that raise awareness and educate people to play an integral role in risk management. Such programmes and efforts help to promote self-protection and ensure adequate behaviour in case of hazard events. Especially by informing and educating pupils, students etc., long-term effects in awareness can be expected.

As Figure 5 shows in a simplified manner, there is a state sphere as well as a societal sphere. The idea is to communicate the knowledge on risks and raise the awareness to establish a risk culture that helps to promote self-protection and self-responsibility. Solutions should be developed together in a risk dialogue and primarily be implemented by the hazard and risk management schemes that exist within the regulatory frameworks of single states. This dialogue concept works on various levels ranging from local communities to international cooperation.

International conventions and frameworks help to spread valuable information and data. The Aarhus Convention[17] plays an important role in this respect, creating transparency and enabling environmental organisations to participate in administrative procedures and ongoing projects. The promotes access to environmental information, public participation in environmental decision-making and access to the legal system. This is a crucial foundation for successful risk communication and an active risk dialogue. Another important basis for receiving information on hazards and risks is the INSPIRE directive (Infrastructure for spatial information in Europe).[18] It lists 34 spatial data issues that member states need to provide information on.

Information plays a key role in risk governance as the concerned people need to have the possibility to inform themselves. It is thus the basis for a risk dialogue and for developing solutions for hazard prevention.

17. *Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, adopted on 25 June 1998, Aarhus.*

18. *Directive 2007/2/EC.*

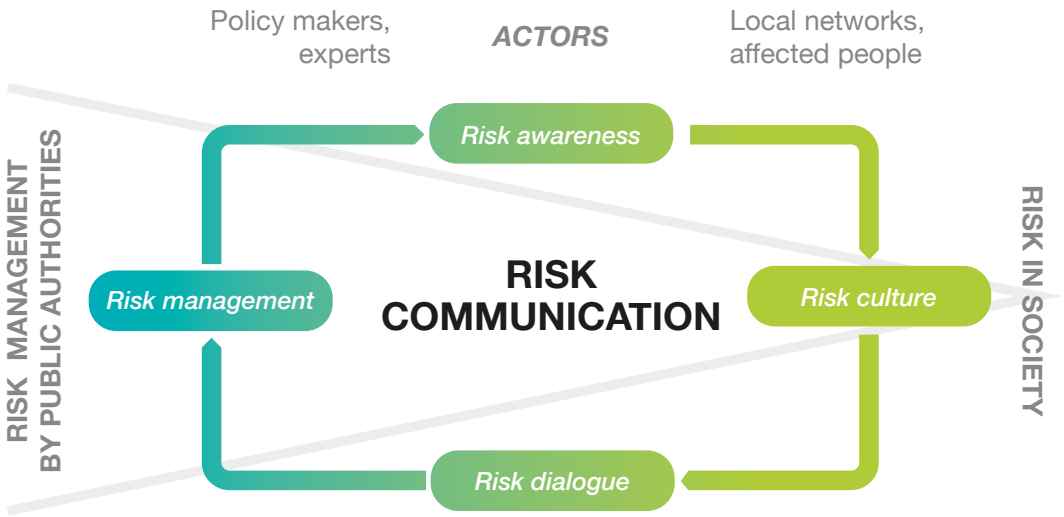


Figure 5: Dimensions of risk governance (Source: IRGC, 2005, adaptation: Schindelegger, 2018)

1.3 INTERNATIONAL FRAMEWORKS FOR DISASTER RISK REDUCTION

The international community has made efforts to strengthen frameworks and develop guidelines for disaster[19] risk management and, more recently, also for risk governance on a global level. The necessity simply derives from the fact that the number of people exposed to natural and other hazards is growing for various reasons, and counter-strategies are urgently needed. Therefore, adaptation and management strategies from a local to a global level are gaining importance.

The United Nations have a tradition of developing global frameworks and guidelines and foster sustainable development by reducing different natural, societal and technical risks.[20] The first global referential framework dealing with disasters was the Hyogo Framework for Action 2005-2015, adopted in 2005 during the 2nd World Conference on Disaster Reduction.[21] Following the 1994 Yokohama Strategy, the overall idea of the framework was to reduce disaster risks through systematically integrated policies, plans and programmes on all levels. In 2015, the Hyogo Framework was followed by the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR)[22], which extended the planning horizon to 15 years and integrated lessons learned from the Hyogo Framework. Despite comprehensive efforts, disasters continued to have severe impacts worldwide. Between 2005 and 2015, more than 700,000 people died and approximately 23 million lost their homes as a result of natural disasters.[23]

The urgent need for enforcing the disaster risk reduction (DRR) framework to effectively protect countries, people, communities, livelihoods, health, cultural heritage, socioeconomic assets as well as ecosystems was obvious.[24] The four identified key priorities in the SFDRR for action are:

(1) understanding disaster risk;
(2) strengthening disaster risk governance to manage disaster risk;
(3) investing in disaster risk reduction to increase resilience;
(4) enhancing disaster preparedness for effective response and a "build back better" approach in recovery, rehabilitation and reconstruction.[25]

The SFDRR is the first framework to identify disaster risk governance as highly relevant on a regional, national and global level as a means to effectively and efficiently manage disaster risk. It is further proposed that a "clear vision plans, competence, guidance and coordination within and across sectors, as well as participation of relevant

19. *The UNISDR defines disaster as: A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.*
20. *E.g. Millennium Development Goals (MDGs), Sustainable Development Goals (sDG).*
21. *United Nations, 2005.*
22. *United Nations, 2015a.*
23. *United Nations, 2015a.*
24. *United Nations, 2015a.*
25. *United Nations, 2015a.*

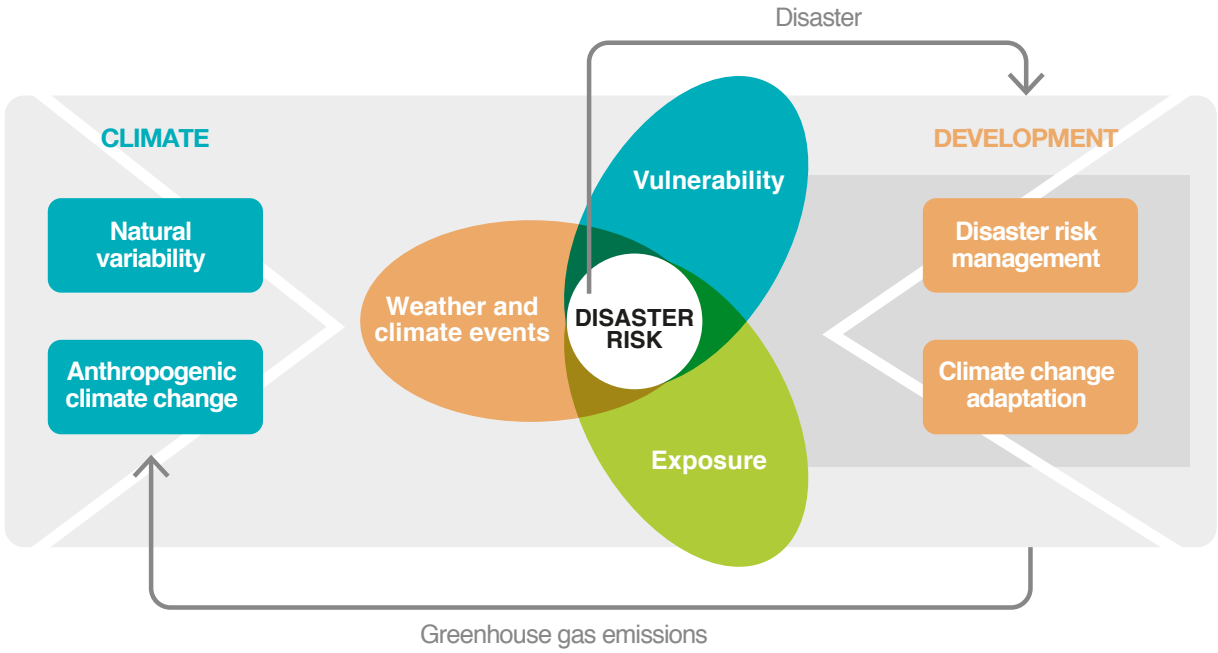


Figure 6: Disaster risk definition by the IPCC (Source: IPCC, 2012, adaptation)

stakeholders, are needed".[26] The SFDRR does not promote a completely new approach to disaster risk reduction if you consider all the policies and efforts already in place in the member states, but it provides a global frame for the shift to a more integrated and risk-based disaster management.[27] For the actual implementation of disaster reduction, the International Strategy for Disaster Reduction (ISDR) managed by the United Nations Office for Disaster Risk Reduction (UNISDR) plays an important role.[28]

New challenges concerning natural hazards have especially been emerging in connection with changing climate conditions. The 17 Sustainable Development Goals (SDGs) of the United Nations provide an integrated target to adapt to climate change and mitigate effects. Several of the SDGs state that urgent action to combat climate change and its impacts is needed and directly or indirectly refer to disaster risk reduction.[29] Target 13.1 for instance aims to strengthen resilience and the adaptive capacity to climate-related hazards and natural disasters in all countries.[30] Risk governance can substantially contribute to achieving this goal on different levels.

Concerning the international efforts to foster climate change mitigation and adaptation, the UNFCCC Paris Agreement [31] plays an essential role. It intends to strengthen the global response to the threat of climate change by keeping the temperature rise in the 21st century below 2 degrees Celsius and aims to strengthen the ability of countries to deal with climate change impacts. This also includes risk reduction and especially the prevention aspect.

The Intergovernmental Panel on Climate Change (IPCC) looks at disaster risk reduction from a climate-change perspective. Figure 6 illustrates the core concept of disaster risk, published in a special report in 2012. It shows that human development is directly linked to changing climate conditions. The resulting shift in disaster risk calls for effective counter-policies.

The different dimensions of DRR suggest that policies and measures to reduce disaster risk work best when addressing not only singular fields. Combined approaches with different perspectives and a certain focus on risk governance seem to be most effective. They involve established stakeholders that have legal obligations in hazard and risk management but also include various other relevant actors. This could increase resilience and lower vulnerability and exposure. So-called *low-regret*

26. *United Nations, 2015a.*
27. *Wahlström, 2015.*
28. *Further information: www.unisdr.org/who-we-are/international-strategy-for-disaster-reduction.*
29. *SDG Targets 2.4, 11b, 13.3, 15.1, 15.2 etc.*
30. *SDG 13. Further information: sustainabledevelopment.un.org/sdg13.*
31. *United Nations, 2015b.*

measures[32] include warning systems, risk communication, land use planning as well as land and ecosystem management.[33]

The European Union is undertaking numerous efforts in the field of disaster risk reduction: first, the regulation and harmonisation of national policies through legal acts (regulations, directives) and second, the facilitation of integrated efforts funded by EU funds (esp. ERDF and EAFRD). This is a set of research and application programmes and macro-regional strategies that aim strongly at intensifying international cooperation and communication. The EUSALP is a fairly new integrated strategy endorsed by the European Council to address common challenges in the Alpine area. Action Group 8 of EUSALP is active in the field of disaster risk governance and climate adaptation governance and cooperates with the Alpine Convention platform PLANALP. For the development of an integrated risk management and risk governance approach for flood prevention, the 2007 Floods Directive[34] plays a crucial role in changing national policies, harmonising measures and fostering an active exchange within the European Union. First of all, flood risk as a term is defined as a "combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event"[35]. This definition helps to generate a common understanding and promotes a risk-based flood assessment and management. The coordination should take place within river basins. Based on special flood hazard and flood risk maps, every member state has developed a flood risk management plan (FRMP) for areas of potentially significant flood risk (APSFR) or generally for all water bodies prone to floods.

On the policy level of the EU, DRR plays an important role as well, e.g. through the actions and funding of the European Commission's Humanitarian Aid and Civil Protection Department (ECHO)[36]. In 2015, the European Commission introduced a new science hub, the Disaster Risk Management Knowledge Centre, which is a focal point of reference in the European Commission and supports the work of the member states as well as European Commission services within and beyond the EU. The recently published Science for Disaster Risk Management report illustrates the need for an active exchange on a scientific as well as a practitioner's level on DRR and DRM to share ideas and solutions.[37]

The Alpine Convention addresses natural hazards both in its legal texts (the Framework Convention and its protocols) and its thematic working bodies. As far as the legal documents are concerned, natural hazards have been of great relevance ever since the Alpine Framework Convention was drafted. Already in Article 2, the Convention states that appropriate measures need to be taken in the domain of spatial planning with "particular emphasis being placed on natural hazards"[38], whereas, further on in the same article, the preservation of the protective role of mountain forests is requested from the Contracting Parties[39].

The fact that natural hazards affect many sectors in the Alps is also reflected by the large number of protocols that include relevant provisions on the topic. For example, the Spatial Planning and Sustainable Development Protocol addresses natural hazards by defining protection against them as one of the goals of spatial planning policies[40] and by invoking considerations on natural hazards to be taken into account in spatial planning programmes[41]. At the same time, the Protocols on Mountain Farming and Mountain Forests address natural hazards from a prevention and protection perspective, including the prevention of natural risks in the core functions of mountain agriculture[42] and recognizing forests as an effective and economical protection "against natural hazards, particularly erosion, flooding, avalanches, landslips and falling rocks"[43]. The Protocol on Soil Conservation also tackles risk management in several parts, most importantly by requiring the Contracting Parties to map areas endangered by natural hazards and to accordingly designate danger zones where necessary[44]. Finally, the Declaration on Climate Change, formulated by the IX. Alpine Conference in 2006, directly addresses the issue of natural hazards in the light of vulnerability and adaptation to the consequences of climate change, invoking an integrated approach for defining adaptation strategies[45]. The action plan resulting from the declaration also calls for a "participative method of risk governance in the planning process"[46], thus paving the way to greater stakeholder involvement and to more inclusive decision-making strategies.

32. *Low-regret or no-regret measures yield benefits even in absence of climate change or natural hazards. The costs of adaptation are relatively low in relation to the benefits of taking action.*
33. *IPCC, 2012.*
34. *Directive 2007/60/EC.*
35. *Directive 2007/60/EC, Art. 2.*
36. *Further information: ec.europa.eu/echo/what/humanitarian-aid/risk-reduction_en.*
37. *DRMKC, 2017.*
38. *Alpine Convention 1991 (Art. 2.2.b).*
39. *Alpine Convention 1991 (Art. 2.2.h).*
40. *Alpine Convention, 1994b (Art. 3).*
41. *Alpine Convention, 1994b (Art. 9).*
42. *Alpine Convention, 1994a (Art. 7.2).*
43. *Alpine Convention, 1996 (Preamble).*
44. *Alpine Convention, 1998 (Art. 10.1).*
45. *Alpine Convention, 2007.*
46. *Alpine Convention, 2010.*

In addition to this legal framework, the Alpine Convention promotes a variety of activities and initiatives that also relate to the management of natural hazards. This is primarily done through its thematic working bodies, the organs established to research, investigate and provide guidelines on different topics that are relevant to the Convention. Besides the above-mentioned PLANALP Platform, whose primary focus is on preventing and adapting to natural hazards, many other thematic working bodies directly or indirectly address natural hazards. First and foremost, the Water Platform has been covering natural hazards in many of its activities and publications because of the numerous implications of natural hazards for water management. This is especially true in the light of floods, sediment transport and nature protection[47]. The Mountain Forests Working Group frequently emphasises the protective function of Alpine forests. This indicates the degree of integrated and multi-sectoral efforts that the Alpine Convention undertakes in the field of natural hazards.

A well-established platform in the field of disaster risk management is the research society Interpraevent. Founded in 1968 in Carinthia, Austria, the organisation aims to bring together researchers and practitioners and provide decision-makers with advice. It organises international events, compiles analyses of natural disasters, publishes scientific work and serves as an important platform for exchange among experts and decision-makers.[48]

On a general level, risk governance is promoted by international strategies, guidelines and frameworks. The importance of governance mechanisms to generate innovative solutions is internationally acknowledged. National regulatory frameworks and practices now need certain adaptations and critical reviewing to further promote risk governance.

47. *Further information: www.alpconv.org/en/organization/groups/WGWater/default.html.*

48. *Further information: www.interpraevent.at.*

1.4 EXTREME NATURAL EVENTS IN THE ALPS

Within the Alpine Convention perimeter several extreme events have been recorded over the past decades. The following three maps show the distribution of such extreme events for avalanches (Figure 7), debris flows and floods in catchment areas smaller than or equal to 100 km² (Figure 8) as well as floods in catchments areas greater than 100 km² (Figure 9). Italy has differing data for extreme events in the Alpine Convention area. Therefore, separate maps are provided in Annex I. The data shows that natural hazards are not just relevant in certain areas of the Alps, but everywhere.

Therefore, people and public authorities throughout the Alpine Convention area need to pursue an active risk management.

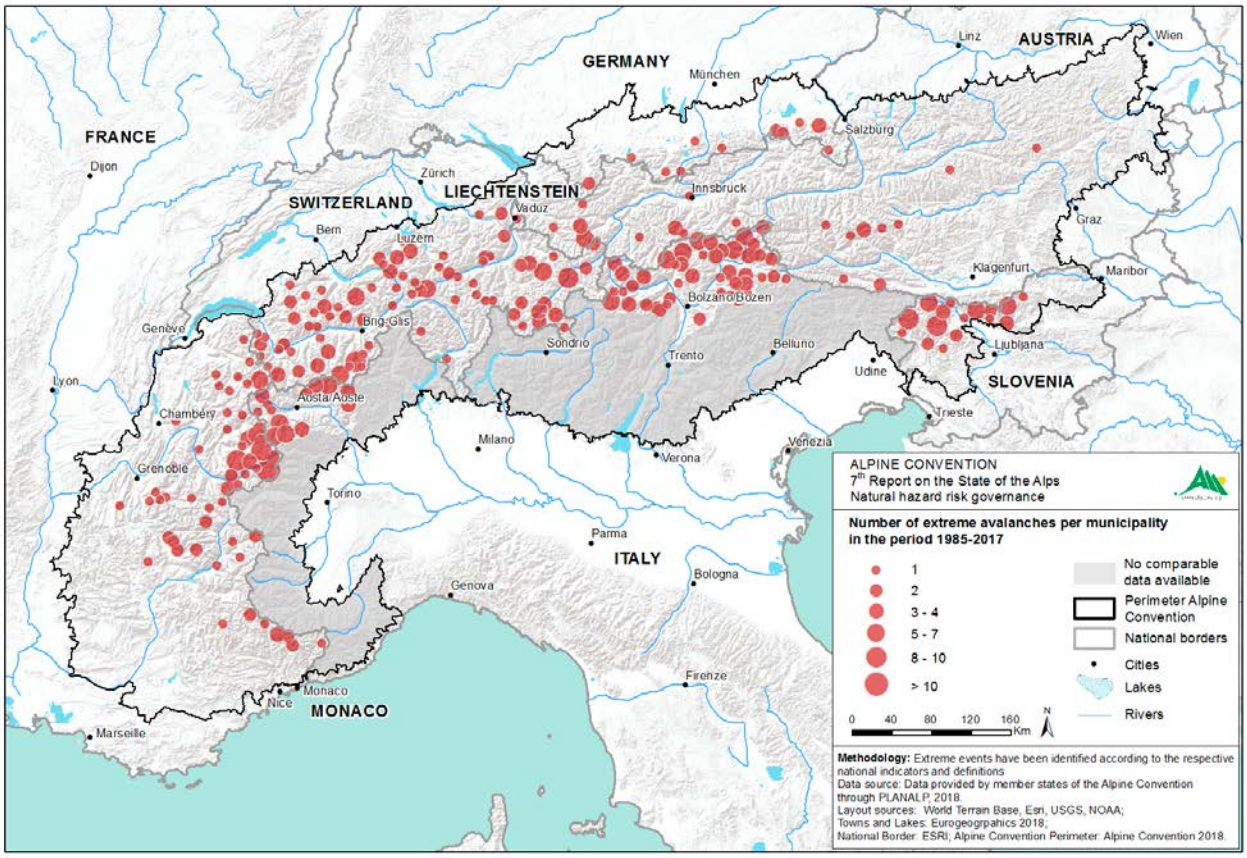


Figure 7: Extreme events in the Alps in the period 1985-2017: extreme avalanches (Data source: PLANALP. Author: Environmental Agency Austria, 2018)

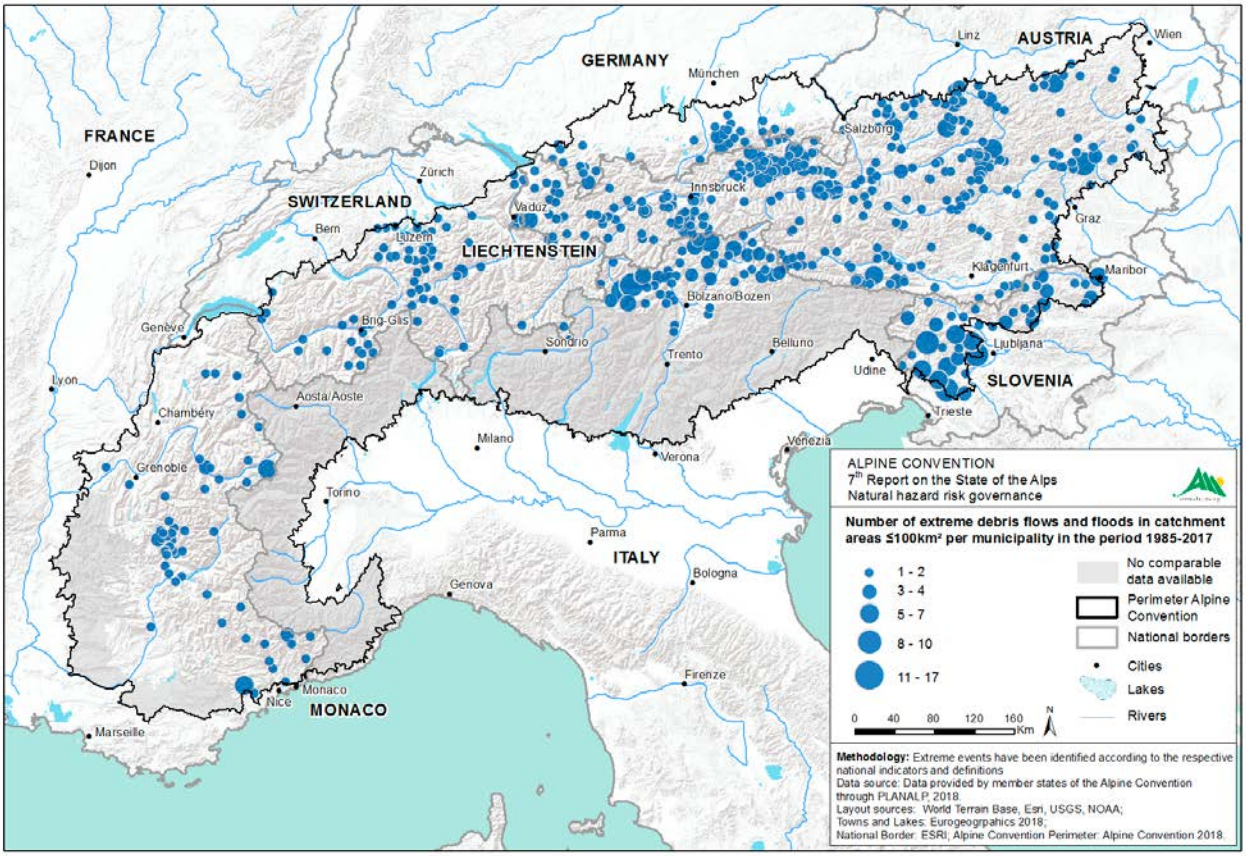


Figure 8: Extreme events in the Alps in the period 1985-2017: extreme debris flow and floods in catchment areas ≤100 km² (Data source: PLANALP. Author: Environmental Agency Austria, 2018)

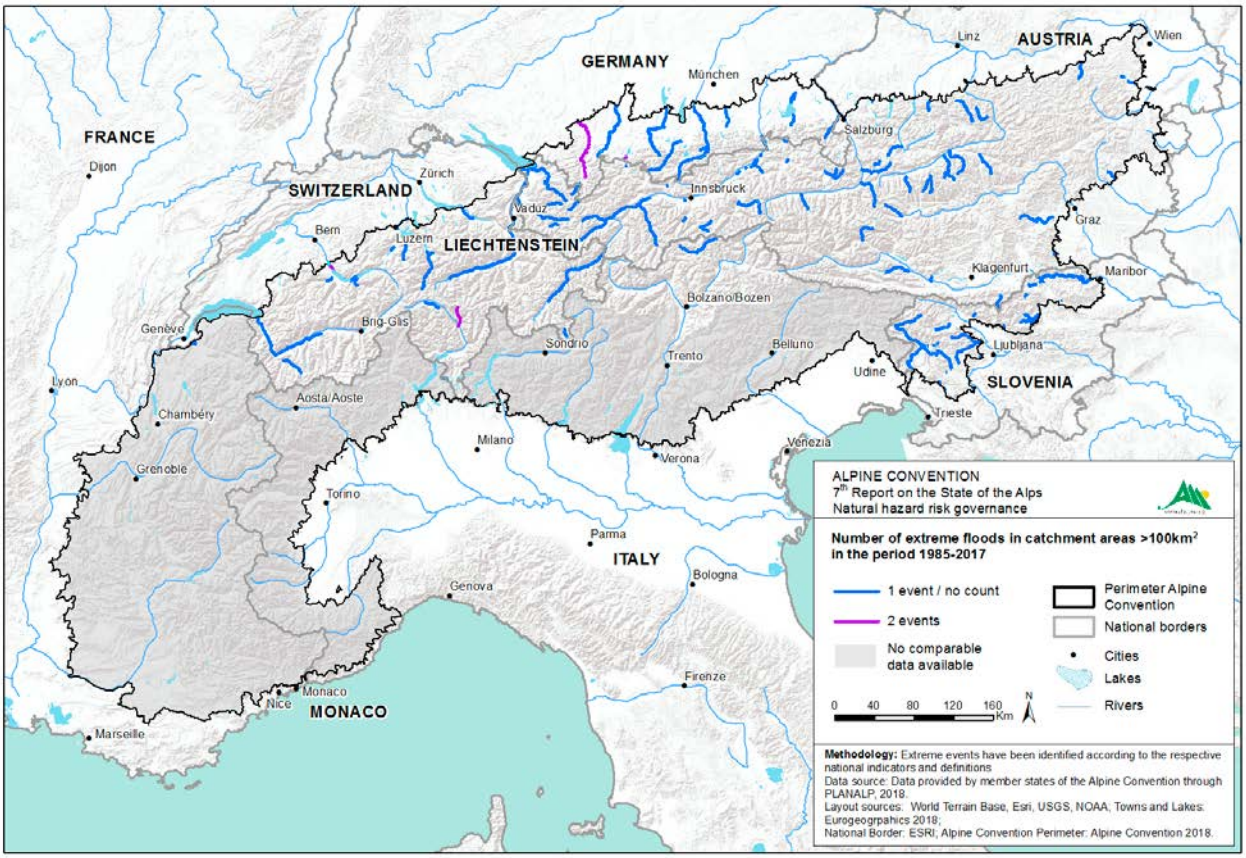


Figure 9: Extreme events in the Alps in the period 1985-2017: extreme floods in catchment areas >100 km² (Data source: PLANALP. Author: Environmental Agency Austria, 2018)

1.5 THE REPORT ON THE STATE OF THE ALPS

The Report on the State of the Alps is a biannual publication of the Alpine Convention that provides detailed periodical information on ecological, economical, and social developments in the Alpine area on a topic which is highly relevant for the Contracting Parties to the Convention. It provides an opportunity to bring together scientists and experts from all the Alpine countries with different backgrounds and perspectives.

The result is an in-depth comparative analysis of the status quo in the Alps, as well as the formulation of recommendations and strategies that can be pursued by the Alpine Convention, its member states or their administrations.

The mandate to draft the Report on the State of the Alps is given by the Conference of the Contracting Parties to one of the Alpine Convention's thematic working bodies. After having dealt with topics like demography, green economy and sustainable tourism, the current Report on the State of the Alps focuses on risk governance. The most apt choice for this task was the PLANALP Platform with its pool of expertise and its long-lasting working structure on the topic of natural hazards. PLANALP draws on the knowledge of experts from the national delegations as well as from Observer organisations. Additionally, a cooperation with EUSALP Action Group 8 was established. Figure 10 illustrates this process in a schematic way.

Figure 10: Drafting process of the RSA (Author: Schindelegger, 2018)

2. EXISTING AND POTENTIAL WAYS OF DEALING WITH NATURAL HAZARD RISKS

For the analysis of governance processes and mechanisms it is essential to identify relevant stakeholders as well as their roles, responsibilities and capacities to contribute to managing hazard risks. The governance concept addresses important overall goals in various ways. Raising *resilience* is one of these goals, addressing the "ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard event in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions"[49]. Researchers as well as politicians use concepts such as resilience and vulnerability to underline that only a joint effort along with holistic perspectives and actions guarantee effective risk management. A torrent in a village, for instance, might require a combination of technical measures to hold back gravel but also fast and well-trained response in case of an event and individual adaptation of buildings (property protection) to reduce potential damage.

The well-known cycle of integrated risk management (see Figure 11) illustrates such a holistic perspective and classifies actions in preparedness, response and recovery phases. The RSA7 primarily examines the aspects of prevention, emergency provisions and preparation for intervention to evaluate what measures exist in the individual member states and to which degree risk governance mechanisms are in place.

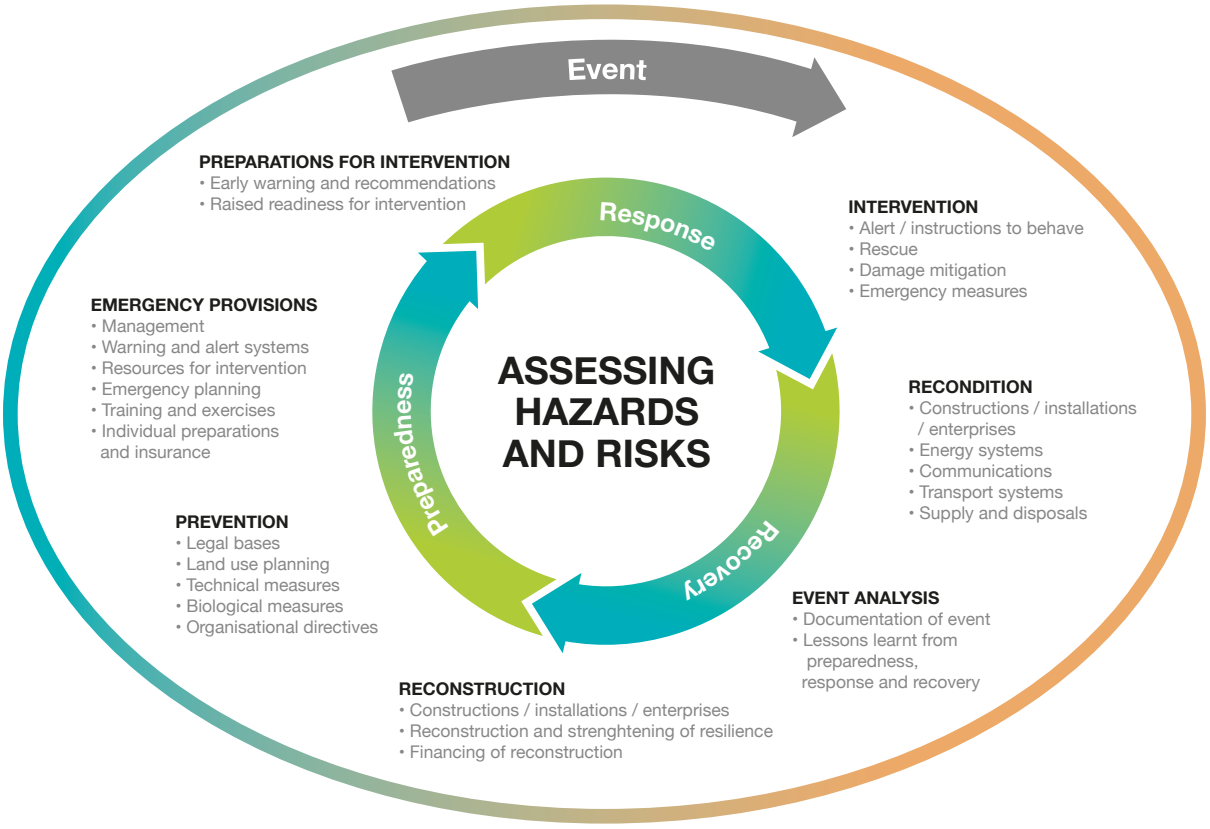


Figure 11: Cycle of integrated risk management (Source: FOCP, 2018, adaptation)

49. EC, 2010.

Every member state of the Alpine Convention tries to limit the threat natural hazards pose to settlements, infrastructure and human lives. However, legislation, funding, and the scope for action are fairly different among the member states. This leads to a need for increased coordination and cooperation.

The respective risk management systems have been established primarily on a national level. They coordinate preventive actions and increase the efficiency and effectiveness of preparedness, response and recovery measures within each country. This is necessary because different administrative levels and sectoral legislation lead to a variety of public authorities engaging in the management of natural hazards. Many scientific and collaborative projects – especially on the European level – have shed light on existing procedural mechanisms to identify and establish synergies between authorities. Risk management cannot always include all concerned parties, local people and NGOs or non-profit organisations on a broad basis. The identification of relevant stakeholders as well as their responsibilities within the governmental system is a first step for moving risk management towards governance processes.

Presenting and analysing these responsibilities and measures in risk management raises the questions of where risk governance is already in place and whether there is a need for it at all.

A critical reflection on existing systems and governmental structures is essential to improve efficiency but also to react to environmental and societal changes. Structural measures based on design events were frequently implemented to protect areas and thus created a feeling of absolute safety. Nevertheless, extreme events have demonstrated that **residual risk** always persists. Structural measures can fail, and hazard events can simply be bigger than design events. Also cascading effects, e.g. a rockfall triggering an avalanche, can occur. These are difficult to predict and simulate. Implementing just one plain protection measure generally does not cover the risk issue adequately. This is where local people and other stakeholders come in and different measures need to get combined.

The common aim is to manage hazard risks in an integrated way concerning all stakeholders and combining the elements of preparedness, response and recovery.

Population growth in the Alps, the construction of infrastructure and an ongoing development of settlements – also in hazard prone areas – increases natural hazard risks constantly. Further challenges are posed by environmental changes. The Alps are a dynamic environment where major physical transformation processes constantly take place (erosion, rockfall, glacial movements etc.). Climate change massively affects the Alpine environmental conditions. Based on the analysis of comprehensive data, scientists aim to forecast effects of changing temperatures and precipitation on natural hazard probabilities. Such projections have to deal with uncertainties but can identify major trends. Scientists have widely confirmed and verified that climate change has an effect on the Alpine environment. It is expected that temperatures will rise by 0.25 °C until the mid-21st century and accelerate to 0.36 °C warming per decade after that. The Alpine snow cover will drastically decrease below an altitude of 1,500-2,000 m, and natural hazards related to glacier and permafrost retreat are expected to become more frequent.[50] A change in precipitation, retreating glaciers and rising temperatures in combination with human settlement activities (soil compaction, sealing of land) also means that flood risks will be changing. Natural hazard processes are therefore not static parameters that only need to be assessed once and remain the same. Especially in terms of changing environmental conditions, society needs to adapt quickly. Risk governance can help to base decisions on a dynamic concept of risk, to take vulnerability and exposure into account, and to seek to activate the population's adaptive capacity on an individual level. Involving the various concerned people and stakeholders can help to identify and implement prevention measures that take into account disaster risk reduction and climate change. Protective forests, for instance, need to be composed of different tree species that can endure the change in temperature and precipitation.

Generally, responsibilities need to be shared by various levels to effectively deal with natural hazards. Preparedness, response and recovery measures need to be combined and developed together to effectively manage natural hazard risks. Ideally, this is done within a governance process.

On the whole, the risk governance discussion is also a mirror of societal changes and needs. The state has been taking care of risk management more or less exclusively for a long time. Affected people long for co-determination – as shown by numerous citizen initiatives – and will not accept decisions made by public authorities that easily anymore. Developing risk management towards risk governance, above all, means taking over responsibilities also on individual, local and regional levels. This is not just about public information and communication but also about actively contributing to risk reduction. Figure 12 illustrates this enhancement of risk management towards a wider involvement and empowerment of affected populations and stakeholders. It shows that risk governance does

50. Gobiet et al., 2014.

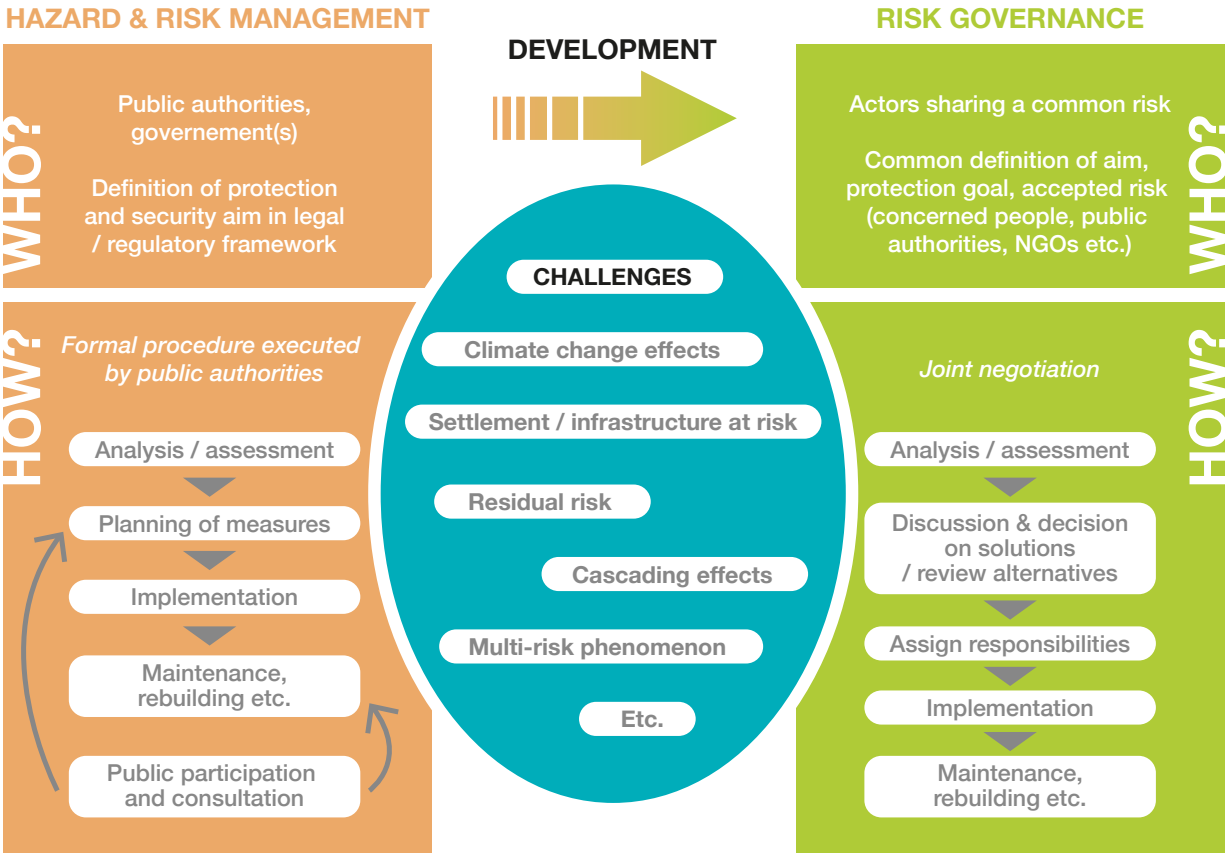


Figure 12: Development from hazard and risk management towards risk governance (Author: Schindelegger, 2018)

not exclude existing regulatory frameworks or compete with responsibilities. In fact, it embeds the existing risk management system in a wider scope. Actors that share a common risk discuss and negotiate solutions together.
Based on these considerations, the following discussion identifies relevant authorities and stakeholders dealing with hazard prevention and preparedness in spatial planning, as well as structural, nature-based and organisational measures and their capacities for fostering risk governance.

2.1 SPATIAL PLANNING

Spatial planning is actually the most effective preventive measure against natural hazards when it comes to new (constructive) developments because it can keep hazard-prone areas undeveloped by prohibiting development or only allowing hazard-adapted development. At the same time, areas suitable for development are rare in the Alpine valleys, and it is simply not possible to completely avoid natural hazard risks. Furthermore, settlement areas and infrastructure are often already located in hazard-prone areas. This results from the historic location of settlements along rivers and the fast growth in the 1950s and 60s without sufficient information on hazards. Spatial planning authorities therefore face different challenges when it comes to natural hazards:

- How should existing settlement areas threatened by natural hazards be dealt with?
- How can strongly endangered areas be kept free of new development?
- What development is acceptable in hazard-prone areas with new protection measures?
- How can residual risk be adequately considered in planning decisions?

These challenges clearly call for strategies and measures on different administrative levels and scales. In almost all Alpine Convention member states, spatial planning is a holistic state responsibility that has to balance social, economic and environmental needs and allocates land uses in line with complex regulations. Natural hazards are considered to different degrees in comprehensive planning activities as well as sectoral plans and programmes. The same applies for residual risk.

Spatial planning tries to regulate the development of the built environment and cannot regulate agricultural land uses. The decision which crop or type of farming is used is made by landowners. Nevertheless, certain land use practices can trigger erosion or increase water runoff and therewith increase hazard risk (e.g. the large scale cultivation of corn in monoculture close to river banks, surface sealing etc.). Due to the nature of spatial planning, it is also hardly possible to address existing legal land uses because of the planning orientation towards future developments. Existing exposure is a topic of (strategic) planning processes, but vulnerabilities so far are not. Spatial planning competencies and authorities on a national level vary across Alpine Convention member states. This implies that the consideration of risk and the implementation of governance processes in planning require different approaches. Austria, for example, has no national planning act and no authority that coordinates national spatial development. France, on the other hand, traditionally had a highly centralised planning system with most of the planning activities converging at the prefectures – the regional branches of the state administration – but has distributed responsibilities more equally over the past decade through administrative reforms. The Ministry for the Ecological and Inclusive Transition is the national authority in charge of spatial planning policies, strategies and the preparation of legislation in France. Germany, which is organised as a federal republic, only has an overall framework legislation on the national level. The responsible ministry for spatial planning is the Federal Ministry of the Interior, Building and Community. Italy, like France, has a more centralised structure with the peculiarity of autonomous regions and provinces. The overall objectives around land use and protection of the territory are set by the Ministry of the Environment and the Protection of Land and Sea and holds coordinating responsibilities. Regions and Autonomous Provinces prepare several regional plans that take flood risks into account. The principality of Liechtenstein coordinates spatial development in much detail on a national level with a comprehensive plan but has no self-contained national planning act. In Slovenia, the Ministry of the Environment and Spatial Planning and the Spatial Planning Act provide a strong national framework for planning principles and instruments. Switzerland has a national overall planning act and a Federal Office for Spatial Development. However, the actual implementation of planning is legally assigned to the cantons, which prepare strategic plans that take natural hazards into account.

Direct legal references to natural hazards in national planning procedures and processes are rare. Overall, planning acts tend to contain a set of development goals and define the planning instruments on different administrative levels. General objectives such as sustainable development, high living standards and a healthy population[51] imply that natural hazards have to be considered in spatial planning.
Natural hazard prevention is mainly addressed on a regional and local level. The principality of Liechtenstein as well as Slovenia have no administrative regional level, while federal states such as Austria, Germany and Switzerland concentrate planning legislation and activities strongly on this level. There is a variety of comprehensive and sectoral plans and programmes in all Alpine Convention member states, but only a few directly address natural hazards. The responsible authorities are normally specific planning units within the regional administration that are led by an elected government official.

The actual land-use planning is generally done by the municipalities. The elected councils adopt different kinds of local development plans and land-use plans, which basically all have the purpose to efficiently allocate land uses, to avoid conflicting uses, and to regulate the intensity of utilisation of

51. *Zakon o prostorskem načrtovanju, 2007 (2. čl.).*

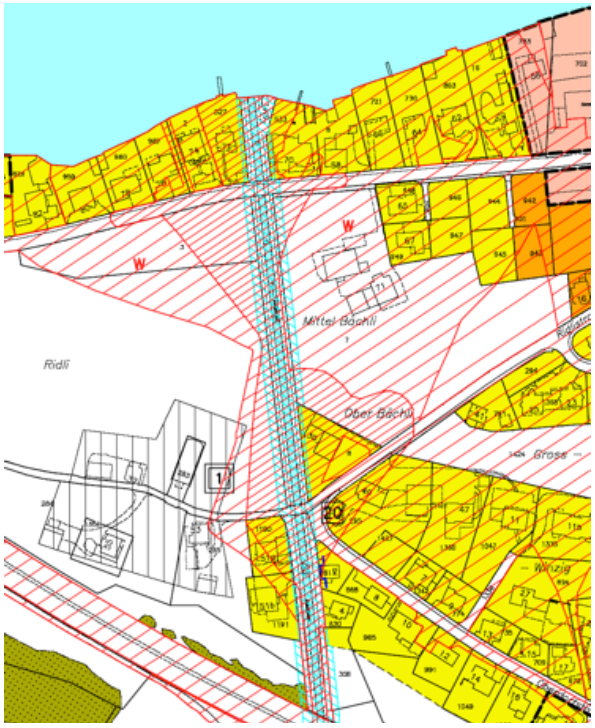


Figure 13: Example: Overlay of hazard zones on land-use categories (Source: FEON, 2018)

single plots of land. Hazard or risk maps are normally included in such municipal plans to display which areas are prone to hazards. Figure 13 shows an example of blue hazard zones (landslides and floods) across different land-use categories. The use of endangered areas for development is thereby restricted.

No simple solution or statement can be provided for dealing with natural hazards in spatial planning that would be valid for all member states. Generally, there is no common strategy to deal with endangered settlements from a planning perspective. Minimizing the hazard risk in hazard-prone areas still relies mostly on structural measures that are designed for certain events and need to consider also overload in order to handle residual risk. One possible planning measure is the zoning of hazard-prone areas that restricts or limits the further structural development or imposes certain requirements. For high-risk areas, relocation is actually a feasible strategy that has been drawing more attention lately as examples from Austria and Switzerland[52] show. Keeping hazard-prone areas free of new development may sound like a simple planning task. In fact, however, the limited availability of suitable land meeting the manifold development interests along with a rather local perspective in zoning lead to ongoing building activities in hazardous zones throughout the Alpine Convention perimeter. Identifying on a regional level areas that are needed for flood water retention, storage and run-off needs efforts of regional and national planning authorities that formulate binding regulations and programmes to foster a broader perspective. One good practice example from Styria, Austria, is a regional framework that helps to consider regional dimensions of floods in local planning activities. A good practice example from Switzerland illustrates how run-off areas for extreme events can be kept free of development with effective spatial planning.

Nevertheless, areas safeguarded by protection measures face another challenge. Large investments by public authorities are simply more efficient, the more households and infrastructure are protected from potential damage. This may lead to more development in protected areas, increasing the potential risk. Thus, it has to be ensured that no new unacceptable risk will be created.

At the same time, protection measures require permanent maintenance and cannot provide protection against extraordinarily big events or even against the failure of single protection measures. Therefore, residual risk (e.g. very big events or structural failure) has to be considered in planning decisions.

Spatial planning simply has to take such considerations into account on different levels and cooperate closely with the authorities in charge of planning and implementing protection measures. Additionally, spatial planning can regulate land use and aim to put vulnerable or critical infrastructure (sawmills in flood areas, hospitals etc.) in low risk areas. On the whole, planning is only one essential aspect in a holistic framework for risk management, which currently relies strongly on the existing regulatory and legal framework.

Planning acts generally create a great degree of transparency. They provide information on where hazard zones are and where development is possible due to the zoning. Local people as well as interested NGOs tend to only have a right to submit statements in formal planning procedures. While participatory approaches are quite common for strategic planning instruments, they have not been established in land-use and development planning. This means that affected people cannot negotiate land use on their property, and the assessment of which type of land use is permissible in hazard-prone areas is made by public authorities.

Spatial planning as the physical arrangement of future land uses has to closely consider natural hazards. Comprehensive analyses of local and regional processes (hazard/risk maps) are already being incorporated in formal procedures to balance development interests. However, planning has clear boundaries by constitutional principles. When private property is concerned, land uses cannot be object to common negotiation. Nevertheless, participatory approaches and governance mechanisms can be applied to effectively formulate and evaluate various interests.

52. BAFU, 2016.

2.2 STRUCTURAL MEASURES

In a traditional understanding, hazard protection is carried out by separate authorities that plan and implement structural measures in line with their responsibility to reduce hazards. Structural measures can be defined as the construction of any physical structure that reduces or avoids possible impacts of hazards or the application of engineering techniques or technology to achieve hazard resistance (e.g. structural adaptation of a house in a floodplain) and increase resilience. Common structural measures in the Alps are dams, flood levees, torrent control and avalanche fences.

Some countries already realized the necessity to assign the planning and implementation of structural measures to public institutions in the 19th century, long before the introduction of spatial planning regulations and modern risk management. Therefore, structural protection measures are based on comprehensive legal and institutional frameworks. This guarantees adherence to technical standards, shared financing and a sufficient justification for measures using cost-benefit analysis. Nevertheless, environmental aspects were often marginally considered. In all Alpine Convention member states, this change towards holistic perspectives in prevention is underway, and environmental issues are nowadays considered as well.

The assignment of responsibilities for planning, implementing and maintaining structural measures varies across the member states. It ranges from individual to municipal, regional and national level and is closely linked to the type of government and administration.

In Austria, there is no formal obligation for the relevant national public authorities (Austrian Service for Torrent and Avalanche Control, Flood Control Management, Federal Waterways) to implement appropriate structural measures for every citizen situated in a hazard area. Basically, the municipalities are the responsible authorities that have to take care of creating an adequately safe environment for the population. If they require adequate assistance in planning and financing measures, they need to apply for it. In France, the Ministry for the Ecological and Inclusive Transition is in charge of the regulatory framework for structural measures. The measures are planned and implemented by local offices in the prefectures. The federal states of Germany are largely autonomous and therefore have differing regulations. Concerning floods, the Bavarian State Ministry of the Environment and Consumer Protection holds the overall water administration and is therefore responsible for tackling the planning and implementation of technical protection measures. Detailed planning and supervision is then carried out by the Bavarian Environment Agency and its local branches in the 7 governmental districts. For small watercourses (category 3), municipalities are responsible. If small water courses are officially defined as torrents, the obligation for protection measures lies with the state of Bavaria. In Italy, there is a similar distribution of responsibilities. There is a national legal framework for risk management, but the actual planning activities are then performed in the so-called River Basin Districts, which do not necessarily conform to the administrative districts. Autonomous regions and provinces, such as South Tyrol, have established an individual regulatory framework and internal authorities in charge of planning and supervising structural measures. In Liechtenstein, the Department for Civil Protection is in charge of all aspects in connection with implementing physical measures for hazard prevention. Slovenia has no regional administrative level, so affected people as well as municipalities and the state are commonly responsible for prevention measures. The Ministry of the Environment and Spatial Planning and the Water Agency generally tackle the planning and implementation of prevention measures in close cooperation with municipalities. In Switzerland, the Federal Office for Environment provides

Figure 14: Check dams – Winnebach, South Tyrol (©Autonomous Province of Bolzano/Bozen, Civil Protection Agency)

Figure 15: Structural protection and retention measures in Bavaria (©Bavarian Environment Agency)

financial support and monitors the appropriate use of resources as well as the implementation by the cantons and defines overall implementation guidelines at national level. The actual planning and implementation of structural measures happens within the cantons. They pass necessary regulations in cantonal laws and assign responsibilities to cantonal authorities. In order to support participative processes in the implementation of protection measures, federal subsidies are available for protection measures undertaken in a participative way.

On the whole, the planning and implementation of structural measures for hazard prevention is strongly regulated, and specific tasks are assigned to different authorities on local, regional and national levels. There is hardly any responsibility of those at risk to undertake preventive measures themselves. Generally, national or regional authorities are in charge of planning and implementing measures as well as financing. The initial request though has to come from the municipalities, which are in most cases responsible for the maintenance of structural measures. Integrated risk management is therefore very important to efficiently organize collaboration and coordination of different public stakeholders. The involvement of the affected population or NGOs is not universally established, and the task of actually designing and constructing protection measures is a rather technical one. Nevertheless, involving the local population in the strategic planning phase and the operational phase of structural measures would be a reasonable extension to the currently rather rigid and formal planning procedures.

Structural measures need an institutional background for planning, for maintaining a positive cost-benefit ratio, for financing, implementation and maintenance. Concerned stakeholders can contribute to the discussion on how to combine which measures and take over responsibilities of managing measures in the long term. Life cycle management is essential to ensure the operability of structural measures.[53] So far, the concepts of governance and risk have hardly been taken into account when it comes to structural measures. However, the good practice examples show that the maintenance of protection structures needs well-trained local forces also during events.

Figure 16: River widening – Mareiterbach; before-after, South Tyrol (©Autonomous Province of Bolzano/Bozen, Civil Protection Agency)

53. PLANALP, 2014.

2.3 NATURE-BASED SOLUTIONS

Another important category of protection and prevention measures against natural hazards are nature-based solutions. This concept is frequently discussed in connection with weather- and climate change-related natural hazards.[54] In this discussion, green infrastructure as a strategically planned network of natural and semi-natural areas that are designed and manged to deliver a wide range of ecosystem services is essential. For the purpose of this report the understanding of nature-based solutions more specifically targets actual hazards and does not look at the basic discussion on how to integrate green infrastructure in our living environment.

There is a variety of nature-based solutions designed to prevent natural hazards and reduce risks. This selection just mentions a few:

- *mass stabilisation* to prevent landslides through specific plantation;
- avalanche and rockfall prevention through *protective forests*; and
- flood protection through a decrease of the amount and speed of *surface run-off* with different kinds of plants.

Nature-based solutions do not require the same amount of maintenance that structural measures do, but other impacts have to be dealt with in order to conserve their protective function. Climate change comes with significant changes in temperature and precipitation patterns that might threaten the functionality of ecosystems, which means that specific care has to be taken to enhance the resilience of the ecosystems themselves. Invasive alien species or pests are destabilizing factors, as are anthropogenic pollution and an unsustainable use of natural resources. This is why nature-based solutions require regular monitoring and an exchange between scientific experts, ecosystem managers, user interest groups, the local population and the responsible public authorities.

Regarding responsibilities for nature-based solutions there are no separate administrative structures. Instead, they are simply considered as a possibility in integrated risk management. Such measures are mostly regulated by the same legal framework as structural measures.

Nature-based solutions strongly take system scale perspectives into account. This means that spatial scales, time scales and the institutional context matter strongly.[55] Nature-based solutions are also very well suited to consider ecological aspects and to prohibit the degradation of

Figure 17: Riparian forest as a valuable nature-based solution in protection systems (©Bavarian Environment Agency)

ecosystems through the implementation of prevention or protection measures. When it comes to flood protection, peatlands and wetlands are important as they have high water storage capacities. Vegetation cover can help to stabilise slopes and reduce the occurrence and amplitude of landslides. Diverse crops can also contribute to soil stability and minimise surface run-off. Restoring riverbeds to increase water storage capacities and steer flow velocity is another nature-based way to prevent hazards.

On the whole, nature-based approaches have been recognized as flexible, cost-effective and broadly applicable tools.[56] They frequently demonstrate a high level of co-benefits (e.g. touristic and recreational potential) and are often considered low-regret measures.

Important nature-based protection infrastructures in the Alps are protective forests.[57] Located on mountain slopes, they prevent and mitigate avalanches, landslides, rockfalls and debris flows. Other plants stabilising the soil with their roots are important as well. Nature-based solutions are often not planned in certain locations. Instead, the protective function is assigned to existing forests or habitats. They are normally multi-functional and depend on different factors. Natural processes as well as human interventions influence this functionality. Serious threats to protective forests are:

- *Climate change*. Average temperature and precipitation are changing all over the Alps. Researchers are therefore trying to assess the effects on protective forests. Forests tend to densify and spread, natural disturbances are increasing, and tree species are changing.[58] Therefore, the composition of species needs to be planned and managed proactively.

54. *EEA, 2015.*
55. *World Bank, 2017.*
56. *Lo, 2016.*
57. *Schutzwald Schweiz, 2018.*
58. *WSL, 2018.*

- *Economic use*. Forests are largely private property and are of economic interest. The legal framework obliges owners to sustainably manage their forests to allow natural regeneration. The interests of the owners and the maintenance of the protection effects need to be balanced out and remunerated accordingly.
- *Hunting*. Hunting plays an important role throughout the Alps. Generally, the number of game animals is very high, and they frequently cause damage to seedlings during wintertime. This influences the regeneration of forests and often thwarts efforts to grow new trees in deforested areas. Coordinating the interests of hunters with the need for functional protective forests is therefore essential.

Figure 18: Protective forest preventing rockfall (©Federal Office for the Environment, Switzerland)

Managing nature-based solutions needs manifold public as well as private actors. All Alpine Convention member states have programmes for financing measures to ensure the functionality of protective forests or to restore them. There are also voluntary programmes and NGOs that undertake and organise initiatives or educational programmes to preserve the protective forests.[59] Like many other regions in the Alps, Bavaria, for example, has established a strategy for protective forests. It aims to restore the function of forests, adapting them to changing climate conditions. The strategy also involves the local population.[60]

Protective forest represents an essential green infrastructure in risk management throughout the Alps. Figure 19 shows the share of protective forest per municipality area. For many municipalities this ratio is higher than 40%, thus highlighting the importance of protective forest throughout the Alpine region.

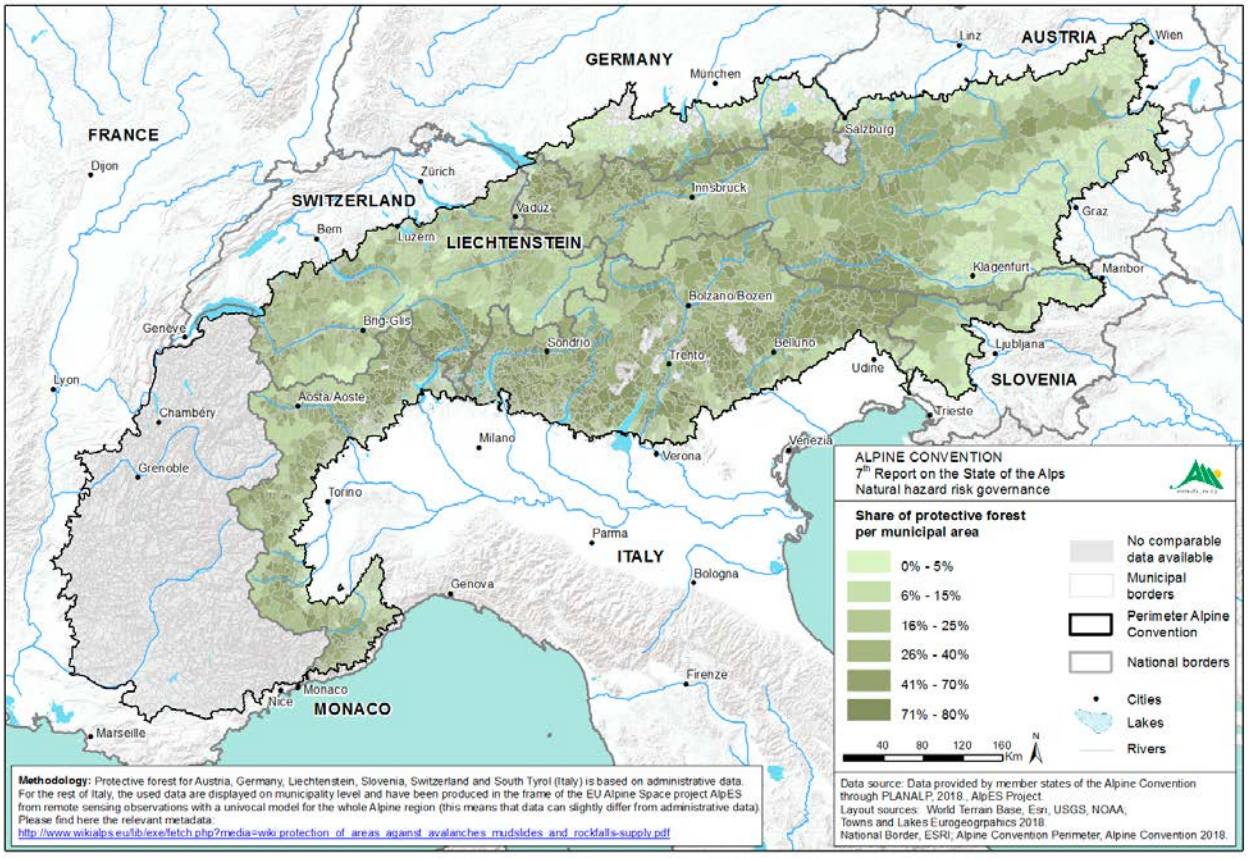


Figure 19: Share of forest with protective function in the Alpine municipalities (Data source: PLANALP, AlpES project. Author: Environmental Agency Austria, 2018)

59. *Further information: www.lwf.bayern.de/waldbau-bergwald/schutzwaldmanagement/009598/index.php.*

60. *Kaulfuss & Höllerl, 2017.*

2.4 ORGANISATIONAL MEASURES

Organisational measures can be described as prepared and trained activities that are carried out just before or during a hazard event to avoid and reduce the damage. Essential components are:

- *information* and *dialogue* with affected people for preparation;
- the *forecasting* of events and their magnitude;
- the *warning* and *alerting* of authorities as well as the population;
- necessary *protective*, *rescue* or *relief measures* and *processes*, such as roadblocks, mobile protection measures, evacuation, assistance for affected people etc., often determined in so-called contingency plans.

All these measures can be summarised within the state responsibility of disaster management. This part of the preparedness phase of the risk management cycle differs strongly from the formal and normative processes in spatial planning and structural and nature-based solutions.

As an integrated aspect, disaster management involves non-governmental and volunteer organisations as well as local people and thus features distinct governance characteristics. All member states of the Alpine Convention have regulatory frameworks for civil protection in place to deal with different kinds of risks and threats for society. The selection of natural hazards in the Alps included in this report represents only a short compendium of relevant topics in civil protection that are widely addressed as disaster management. Natural hazards occur with strongly differing extents. Rockfall, landslides, avalanches and torrents are local phenomena, while floods often have regional, national or even transnational effects. Therefore, hazards can affect individuals, parts of a settlement area or infrastructure, single municipalities, entire valleys or even larger spatial units. In all member states of the Alpine Convention, organisational structures are in place to cope with events on the appropriate level. This means that different institutions on different levels deal with events according to the territorial scope of the event and can call for additional support and help if the local, regional or national capacities are insufficient. Responsible authorities prepare operational plans and coordinate training programmes for potential hazard events. If such an event occurs, rescue and relief units try to evacuate people and undertake measures to minimize the damage. For such operations, manpower is needed, and therefore different NGOs and even civilians are integrated in disaster management on a local level. Operational centres on different administrative levels organise the communication and tasks of rescue and relief forces during events. This is simply necessary to coordinate the different forces and provide adequate support and technical assistance. All Alpine Convention member states therefore have appropriate legal acts for disaster management.

Disaster management in Austria is legally assigned to the provinces, which have established administrative authorities. The general coordination is carried out by the Federal Alarm Centre within the Ministry of Interior (since 2006) as well as the national coordination committee comprised by the Ministry of Interior, rescue organisations, federal ministries, the provinces and external experts. The lead in actual operations depends on the scope of the event. Operations can be managed at municipal, district or provincial level in line with the according disaster management plan. In France, the Ministry of Interior with its Directorate of Civil Defence and Security has the coordinative responsibility for disaster management, and legislation is set at national level only. The operational centres are established on the regional level operating according to emergency plans. The affected municipalities provide only primary emergency aid. Germany has a subdivision of competencies and a similar disaster management system as Austria. The Federal Government with its institutions (e.g. Office for Civil Protection and Disaster Assistance, armed forces and police) provides coordination and substantial rescue and relief assistance. The actual operations are led on a municipal, county or state level. The organisational structure and quantity of regulations for disaster management in Italy is rather complex due to the administrative division with legislative, administrative and financial home rule for autonomous regions and provinces. Comparable to other member states in the Alpine Convention, the overall coordination is set at the national level. There is a National Functional Centre, an Operational Committee and a Command and Control Direction within the National Civil Protection Department. Regions, provinces and municipalities have their own operation centres with different responsibilities according to regional legislation. There is a subsidiary principle for events, and national forces can be requested if events exceed local or regional capacities. Liechtenstein has a rather unique organisational structure with a National Management Council directing the operational headquarters and a technical operation control that is supported by municipal management councils. Due to the small size of Liechtenstein, all events are managed on a national level, and the coordination with the neighbouring countries is paramount. Disaster management legislation and execution are done on the national level. The Republic of Slovenia has established the Administration of the Republic of Slovenia for Civil Protection and Disaster

Figure 20: Cooperation between different rescue and relief forces and civilians (©Bavarian Environment Agency)

Relief within the Ministry of Defence, preparing national emergency response plans, servicing the warning systems, and training rescue and relief units. Minor disasters are handled by civil protection commanders and their staff on a municipal or regional level. Disaster management in Switzerland has a legislative and administrative branch, with the Federal Office for Civil Protection within the Department of Defence, Civil Protection and Sport serving as the main coordinating unit on the national level. Besides the Federal Act on Civil Protection and Civil Defence, the individual cantons organise disaster and emergency management legally as well as administratively in their territories. On the different levels (municipal, cantonal and national), management structures have been established to coordinate the so-called partner organisations (police, fire brigade, medical services and infrastructure providers). Depending on the scope of the event, the national level might support the cantonal and municipal level by providing sufficient information on the event as well as delivering warnings and alerts to authorities and the population.

Throughout the Alpine Convention perimeter, disaster management follows the principles of subsidiarity and adaption to the extent of the events. Municipalities generally play an important role for handling minor events while the regional authorities (e.g. districts, counties, federal states and provinces) mostly coordinate rescue and relief units and manage the whole operation. Only in large scale (federal) events, armed forces or international support are requested.

In all presented countries, non-governmental rescue and relief forces such as the Red Cross, fire brigades or water and mountain rescue units play and important role in dealing with certain hazard events. Additionally, infrastructure providers are included in the preparatory planning. Based on hazard and risk maps, operational plans are prepared to coordinate the different rescue and relief forces in terms of capacity, location and tasks. The various organisational measures also strongly rely on the local population and non-governmental organisations. A risk governance approach, however, would imply involving such actors in a strategic and early stage of developing holistic concepts and measures for hazard prevention and risk management. This already happens throughout the Alps in different regions.

3. RISK GOVERNANCE ACROSS THE ALPS – AN OVERVIEW

Providing an overview of the status quo of risk governance for natural hazard risk and mapping governance mechanisms and processes within the Alpine Convention perimeter is challenging due to the simple fact that governance largely occurs on a local and regional level, where the concerned people are involved in the context of actual projects and immanent challenges. At the same time, improvements in the coordination and cooperation of involved public authorities do not always represent governance mechanisms. As stated in the introduction, risk governance can be described as the various ways in which all interested subjects manage their common risks. It is therefore essential to first evaluate the knowledge of existing risks before determining the characteristics, qualities and capacities of risk governance mechanisms that are in place in the individual member states.

3.1 MAPPING HAZARDS AND RISKS

Mapping hazards actually has a long tradition. Since the medieval ages, analysts have been recording large events, and people living next to rivers have been indicating flood marks on their houses. In some member states, the systematic collection of data and the professional calculation and estimation of hazard zones already started in the 1950s, 60s and 70s. Ever since, the models for simulating avalanches or calculating floodwater run-off have become more precise and accurate, as occurring events have proven. Mapping hazards was never an altruistic task. Such information was crucial for designing effective preventive measures and for planning decisions. Authorities started to distinguish between areas with high hazard potential, where buildings were likely to get destroyed and lives were at risk, and areas that were regularly affected by hazards but were still suitable for certain development. The overlapping of different hazard zones was often not considered in the designation, and neither was residual risk.

Concerning settlement areas, the general aim was to minimize red high-risk zones through structural and nature-based solutions. The first generation of hazard maps mainly served as a basis for planning protection measures. Spatial planning incorporated hazard information later on. Hazard maps can be upgraded to risk maps by including damage potentials within certain zones, residual risk and the risk of structural failure. Such maps are fairly complex and face the problem that actual land use is dynamic and permanently changes. A summer campsite, for instance, could be approved in a hazard zone for avalanches but would be highly vulnerable in a rockfall zone. Due to the highly complex and dynamic data, it is difficult to establish printed risk maps.

All member states of the Alpine Convention have developed certain types of hazard and risk maps using different colour codes and reference events as a basis. This makes it difficult to compare them. Concerning governance mechanisms, it is especially interesting to examine how local knowledge is integrated and matched with existing spatial policies and strategies.

Hazard and risk mapping in the EU underwent a universal change when the Floods Directive of the European Union[61] was introduced. The directive was a highly relevant starting point for a shift in national policies, harmonisation of measures and intensified international cooperation. First of all, flood risk as a term was defined as "a combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event". This has helped to generate a common understanding and to promote a risk-based flood assessment and management. Based on the Preliminary Flood Risk Assessment (PFRA), every EU member state developed flood hazard and flood risk maps as well as an according Flood Risk Management Plan for areas with potentially

61. *Directive 2007/60/EC.*

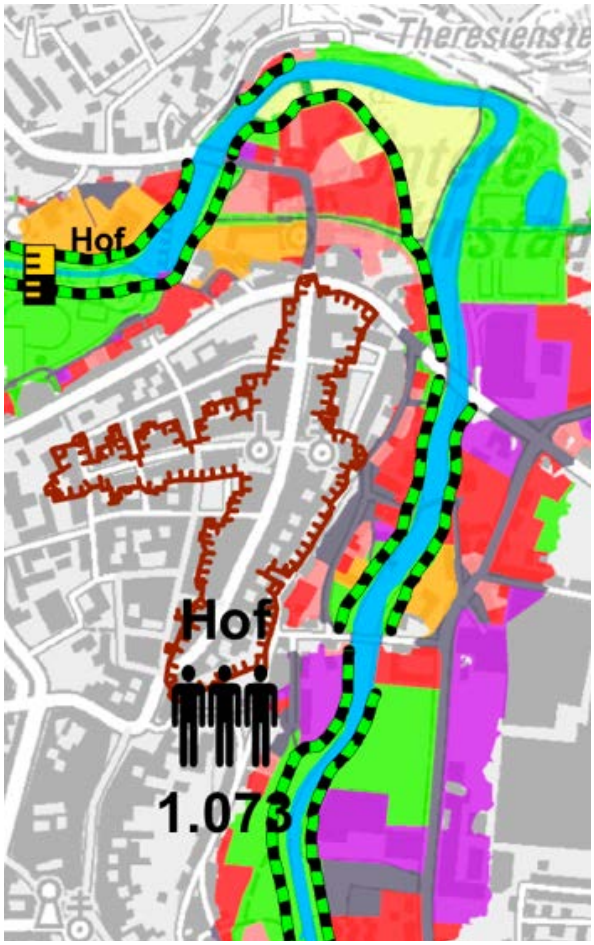


Figure 21: Flood risk map, Bavaria (Source: LFU, 2013)

significant flood risk. Hazard and risk maps were thus only drafted for sections of rivers, and the FRMP addresses only these sections. Some river catchments like the river Main in Bavaria were generally defined as APSFR. Nevertheless, in many areas these were the first flood risk maps combining damage potentials with flood hazard zones (Figure 21).

Austria currently has different types of hazards maps drafted by different authorities at national and partly at regional level. While Austria has clear guidelines and great expertise in handling hazard zone maps, they have no binding character. In fact, they only have the legal status of an expert advice. Local people and municipalities are involved in the drafting process to integrate local knowledge. Immense efforts have been undertaken to reach full coverage of these maps for avalanches, torrents and floods. For landslides and rockfalls, so far only susceptibility and individual hazard maps are available for the main part.

France introduced the Natural Risk Exposition Plan in 1982, which was replaced in 1995 by the Natural Risk Prevention Plan (PPRN). The responsibility for hazard and risk mapping was assigned to the state and specifically to the General Directorate for Prevention of Risks. The PPRN covers spatially displayable hazards and clearly defined danger zones (red zones) and precautionary zones (blue zones). It defines measures for prevention and protection as well as measures for existing land uses. Risk is therefore an integrated aspect of such plans.

Hazard and risk mapping in Germany is assigned to the federated states. Given that only Bavaria is situated within the Alpine Convention perimeter, only their mapping system was analysed for this report. Hazard and risk maps for floods have been established due to the implementation of the Floods Directive. So far, there is no comprehensive hazard mapping system. For rivers, the areas for 100-year record flood events have been defined. Landslide susceptibility maps exist on a big scale.

Due to its wide exposure to different natural hazards, Italy is culturally, scientifically and organically equipped for the management of natural hazards and the risks associated with them. Hazard and risk mapping are articulated on different territorial levels, from the river districts to the municipalities, taking into account floods, hydrogeological instability, avalanches, extreme meteorological phenomena, volcanism and earthquakes.

Regions, Autonomous Regions and Autonomous Provinces are independently producing their own hazard and risk mapping, clearly on the basis of hazard and risk level standardized at national level and taking into account flood risk as assessed by the District Authorities in the Flood Risk Management Plans (as for the Alpine area, concerned River Districts are Northern Apennines, Po river, Eastern Alps). In hazard/risk maps different zones according to event probabilities and the degree of exposure are distinguished. According to the consequent risk assessment, non-go areas are then included in land planning at regional, provincial and municipal level.

With regard to hazard mapping and risk targeting at national level, in particular, the WebGIS service implemented by the "Italiasicura" Mission Unit (unit directly managed by the Presidency of the Council of Ministers), allows anyone to obtain detailed information on the hazard of flooding and landslide related to a given area on the entire national territory. The service also provides information on exposure of human lives, settlements, schools and cultural heritage, thus presenting together hazardousness, exposure and vulnerability.

The High Institute for Environmental Protection and Research (ISPRA), the national Department of Civil Protection and the National Institute of Geophysics and Volcanology (INGV) are other institutions of national relevance which develop

important research and monitoring activities on risks and natural hazards.

Italy has also been active in the Interreg risk assessment projects RiskNat and RiskNet. In the first project the involvement of economic-financial stakeholders in procedures for mitigating natural risks was explored. In RiskNet, the concept of sustainable risk was developed to better include economic losses caused by natural hazards. Here not only economic damage, but also impacts on the social system are evaluated. Natural hazards pose serious threats to economic assets and therefore the sustainable risk concept aims to include this perspective in a holistic risk management.[62]

The Principality of Liechtenstein established the legal basis for hazard maps in 1991. The system was developed individually for the local needs and for all relevant natural hazards. Figure 22 shows the impressive colour coding scheme as well as the large extent of hazard zones. Already in 2004, risk maps were introduced to adequately consider damage potentials in the decision-making processes for preventive measures.

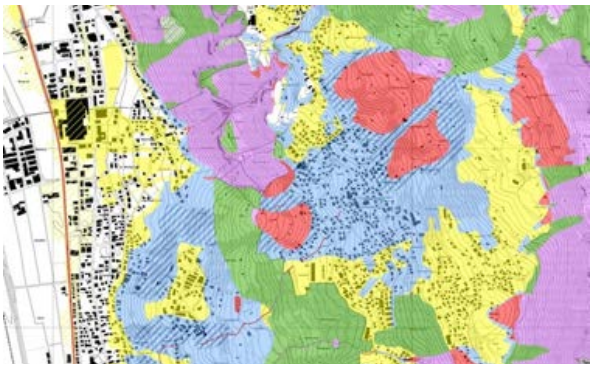


Figure 22: Hazard map, Liechtenstein (Source: Office for Civil Protection, Liechtenstein, 2018)

In Slovenia, regional hazard maps (scale 1:10,000-1:4,000,000) are available for the whole country. Furthermore, there are local hazard maps based on detailed simulations and calculations.[63] In connection with the implementation of the Floods Directive, flood hazard and risk maps with a binding character for land-use planning have been drafted.

Hazard mapping in Switzerland is assigned to the cantons. The Federal Office for Environment provides a very elaborate system for mapping different natural hazards that most of the cantons are using. For avalanches, floods and rockfalls, more than 92-99% of all relevant areas are mapped. For landslides, 88% of all relevant areas are covered. Preliminary hazard maps are included in regional planning documents. For actual land-use planning and the planning of structural measures, detailed maps that distinguish different zones for different kinds of development are available.

MAPPING RESIDUAL RISK

Many hazard maps distinguish only two to three categories of hazard areas based on the probability of events. Existing protection structures are taken into account in such calculations and simulations. Since hazard events can exceed design events, and protection measures can fail, there is always a residual risk. Living in assumingly "safe" areas does not mean that no hazard events can occur. Therefore, mapping is increasingly demarcating such areas. Nevertheless, residual risk is hardly manageable as it is impossible to map unknown risk.

In general, drafting hazard maps is not only a matter of computer simulations and calculations. It also requires local knowledge and needs to consider different perspectives. Complex simulations and calculations as well as past events with physical evidence and local perspectives are taken into account. As shown, the responsibilities for mapping hazards and/or risks differ widely among the member states. Most states now have guidelines for preparing hazard and risk maps on a national level. The actual preparation takes place on local, regional or national level with a focus on providing preliminary hazard maps, hazard zone maps and, more recently, also risk maps. The governance aspect for hazard mapping is, on the one hand, the inclusion of local people in the preparation process and, on the other hand, the public provision of the maps to raise risk awareness. While hard copy maps from the past were hardly accessible to the general public, all member states now provide extensive information online. Thus, the governance aspect is clearly given when it comes to the preparation and availability of hazard and risk maps. Figure 23 gives an overview of the availability of information on hazards and risk via maps on the municipal level. Generally speaking, this mapping is very advanced and relevant information on floods, debris flows, rockfalls and landslides is widely available

62. *Further information: www.risknet-alcotra.org.*
63. *Mikoš, 2013.*

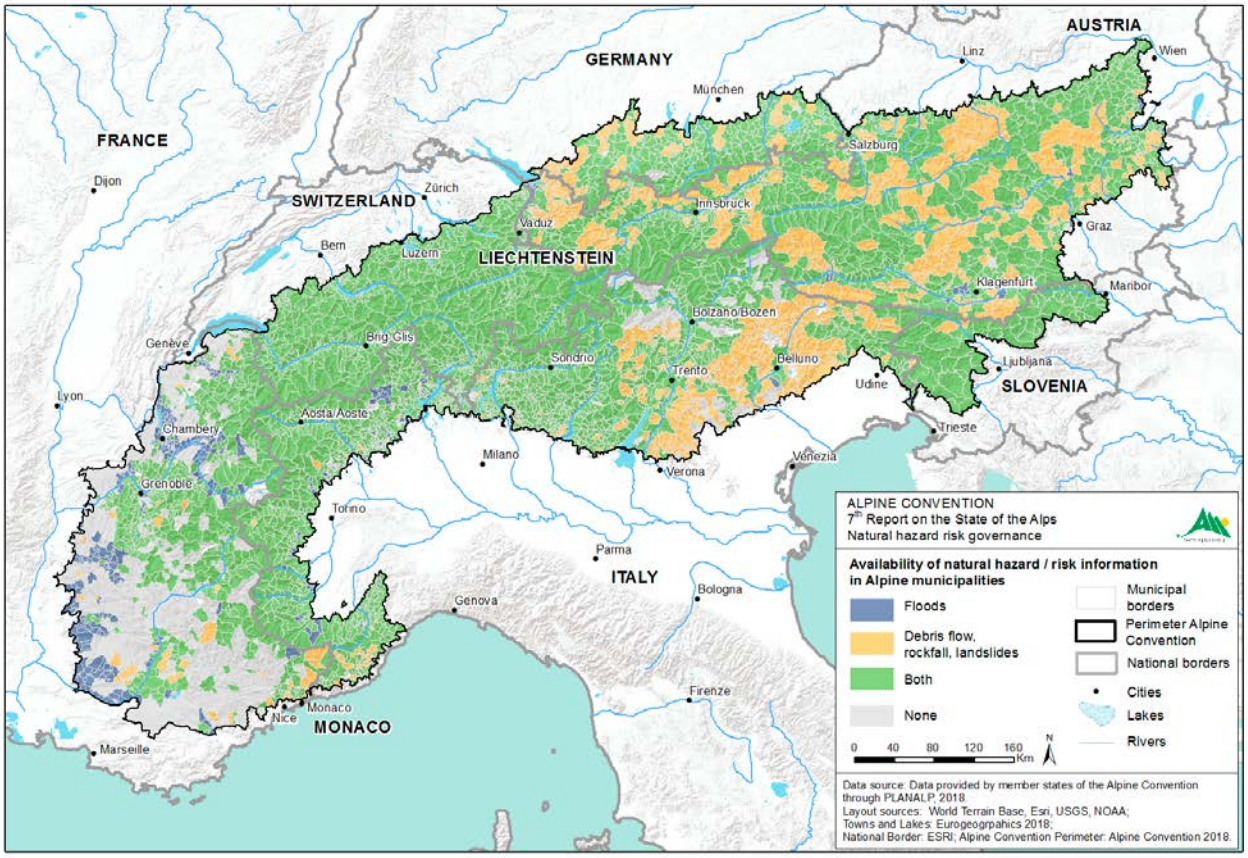


Figure 23: Available information on hazard and risk in Alpine municipalities (Data source: PLANALP. Author: Environmental Agency Austria, 2018)

LINKS TO ONLINE INFORMATION

Austria:	www.naturgefahren.at
France:	www.georisques.gouv.fr
Germany, Bavaria:	www.umweltatlas.bayern.de/naturgefahren
Italy:	mappa.italiasicura.gov.it
Liechtenstein:	geodaten.llv.li/geoportal/naturgefahren.html
Slovenia:	gis.arso.gov.si/evode/profile.aspx?id=atlas_voda@Arso
Switzerland:	www.bafu.admin.ch/gefahrenkarten

3.2 RISK GOVERNANCE IN THE ALPS – STATUS QUO

Mapping risk governance for natural hazards means analysing the existence and importance of local, regional, national or even international governance processes that aim to reduce the risk of natural hazards by developing a variety of mostly consensual solutions. The challenge is to first identify such processes and then assess them in a manner that makes comparative conclusions possible. Risk governance as a negotiation process among peers, parallel to formal procedures or included in such, cannot easily be identified in desk research. Therefore, the members of the PLANALP working group of the Alpine Convention each contributed with their experience and knowledge in their fields of work. This approach also brings limitations in gathering relevant information, as the present report cannot be universal in its statements but only cover tendencies and efforts.

The status quo analysis is divided in separate assessments of planning, structural, nature-based, and organisational measures and concludes with an overall statement on the status quo of natural hazard risk governance.

3.2.1 RISK GOVERNANCE AND SPATIAL PLANNING MEASURES

Spatial planning has developed different local, regional and/or national instruments for managing the physical development of the territory. On a national level, predominantly strategic concepts and spatial policies aim to define overall goals and coordinate the different sectoral policies in place. France, Germany, Italy, Slovenia and Switzerland all have national framework legislations for spatial planning. Depending on the governmental and administrational structure, there are further spatial planning laws on a regional level. In general, planning goals are specified on a regional level, and different planning concepts and programmes are implemented to balance development throughout the territory. Land-use planning is basically carried out by local municipalities. In all member states of the Alpine Convention, the planning system is strongly normative and based on a variety of legal acts and decrees. The participation of the public and concerned parties is therefore also very formal and often limited to the right of submitting statements. Strategic concepts and policies are open to different forms of participation, especially on a local or inter-municipal level. As a state responsibility, planning is performed according to rules and procedures, and the discussion on different development choices is normally undertaken by elected municipal councils and not the general public. However, instruments of direct democratic decision-making do exist.

Natural hazards are addressed on all administrative levels of spatial planning. On a national and regional level, they are mainly related to the goal of providing a safe living environment for the people. Thus, in land-use planning, there is often a direct reference to hazard zones. Regional planning frequently uses preliminary hazard maps in concepts and plans (e.g. Switzerland) but rarely addresses natural hazards directly as a separate sectoral topic. Precisely how hazards are addressed on a regional level differs widely. The River Basin Districts in Italy implement such a regional perspective on a general formal basis, while others have introduced voluntary discussion forums.

On a local level, natural hazards are an integral part of municipalities' planning activities. The consideration of natural hazards in local land-use planning is mandatory everywhere. If no hazard or risk maps are available, expert advice is required. The categorisation of different hazards, however, differs widely among Alpine Convention member states. Hazards are generally considered, but risk and cumulative effects are hardly taken into account. This is due to limitations in local planning, which cannot determine agricultural land uses and the correlation of the density of real estate development with risk. In Switzerland, two experimental projects for risk-based spatial planning were undertaken. They have shown that risk needs to be considered already at an early planning stage and that besides its basic feasibility, legal and procedural questions remain unanswered.[64]

Spatial planning decisions, especially at a local level, have to follow strict procedures based on constitutional principles. They only allow limited and formalised involvement of the public. The strategic orientation of planning measures, on the other hand, is open to discussions and active participation (e.g. local knowledge for analysis, developing a vision for a resilient community etc.). Spatial planning itself needs to be integrated in governance processes to develop effective hazard prevention solutions. The aim should not be the general transformation of planning procedures to governance processes. Instead, the focus should be on integrating planning in governance processes and using planning measures and instruments to achieve a long-term risk reduction. Essential contributions of risk-based planning are:

- *long-term protection of hazard-prone areas and retention areas* (keep them free of development);
- *holistic consideration* of hazards in the distribution of *land uses*;

64. *Camenzind, Loat, 2014.*

- placing *sensitive land uses outside hazard zones*;
- defining *balanced inter-municipal and regional frameworks* that take risk into account.

Especially the long-term protection of hazard-prone areas and retention areas on a local level needs to be based on more than just legal titles. Comprehensive discussions and well-founded decisions require the willingness of decision-makers, property owners and municipalities to cooperate. At the same time, inter-municipal allocation of development relies on the collaboration of politicians to achieve development solutions that do not increase the risk posed by natural hazards.

When analysing spatial planning and its role and relation to natural hazard risk governance within the Alpine Convention member states, several recommendations can be highlighted:

- *Introduce risk as a spatial planning principle*: foster risk as a referential framework for planning decisions on all levels.
- *Define clear spatial planning goals* for risk reduction on all levels: address hazard risks on all planning levels and formulate specific protection goals.
- *Strengthen regional perspectives*: some hazards – especially floods – require regional collaboration for risk reduction. This includes the development of regional compensation mechanisms.
- *Integrate spatial planning in a holistic risk reduction framework*: spatial planning provides different instruments and measures to manage hazard risks. Therefore, planning needs to be integrated in discussions and processes on different levels to also reach local decision-makers. This requires coordinating boards for every case as well as transparent communication and cooperation with other relevant authorities and sectors.
- *Provide information to a large audience*: make maps and plans accessible that show planning regulations, hazard areas and, if possible, risks to provide transparent and understandable information for the public.

3.2.2 RISK GOVERNANCE AND STRUCTURAL MEASURES

Protecting settlements and infrastructure against natural hazards through structural measures is a cost-intensive but common practice. For many hazard areas, technical measures seem to represent the only feasible option to protect settlements. Identifying areas in need of measures happens widely on the basis of hazard (or risk) maps. The planning of structural measures is a rather technical and therefore not so much governance-based discipline. It is a rather normative practice established by laws, decrees and guidelines that regulate planning procedures and cost issues. However, the execution of procedures is not only based on a legal framework but also encompasses local stakeholders. The planning and implementation of single structural measures might not have many governance elements, but local people whose property is needed for building structures are strongly involved through discussions and negotiations. Prompt solutions and agreements are built on mutual understanding as well as transparent communication. Government officials are requested to be empathic and at the same time have the overall aim in sight. This is simply necessary because structural measures are not favoured by every stakeholder and normally imply the loss of (compensated) property for certain parties. Therefore, affected parties and the local population need to be integrated to a certain extent. Measures like river widenings as well as regional structural measures tend to be more governance-based. The more property owners and municipalities are involved in the development and implementation of certain measures, the more important transparent participatory approaches are. Normally, state authorities in charge of planning structural measures undertake the coordination of such processes including a variety of stakeholders ranging from local people and different public authorities to NGOs that bring in ideas for a sustainable and balanced development.

Structural measures are therefore not only a state responsibility dealt with by public authorities. Instead, they frequently require local negotiation processes. Measures of regional importance that involve different administrative units are very well suited to be perceived as risk governance processes. Measures concerning flood risk management are far-ranging, while measures for other hazards normally only have a limited local impact. Governance aspects are also important for maintenance. Structural measures need maintenance and ongoing financial support to fulfil their protection function. As the good practice example of the Austrian water boards shows, networks that define responsibilities and financial contributions help immensely to maintain structural measures in the long-term. It is also important to have local trained forces that run structural measures in case of events, as the good practice examples of Liechtenstein and Switzerland show. Such processes around structural measures hold interesting governance aspects and generally reduce risk significantly, keeping it low in the long run.

Planning and developing structural measures can be described as rather formal procedures. Implementing governance mechanisms means to open the discussion at a very early stage. It means discussing at eye level among peers which measure or which combination of measures

would work best in certain locations and how the financing and maintenance is best organized. The ultimate decision is still made within the legal and regulatory framework by the responsible authorities.

The following recommendations can be made when it comes to risk governance for structural measures within the Alpine Convention member states:

- *Structural measures are one component of natural hazard and risk management:* involving concerned stakeholders in the negotiation of risk reduction measures can foster inter-sectoral cooperation and promote risk governance. Structural measures are thereby only one instrument in the toolkit.
- *Strengthening regional perspectives:* the planning perspective needs to shift from local risk reduction effects of structural measures to holistic regional perspectives.
- *Distributing responsibilities:* responsibilities concerning maintenance and financing of measures need to be shared to strengthen commitment and local awareness for natural hazard risks.

Generally, structural measures need intensive preparation to be effective long-term risk reduction measures. They are designed for certain events and can suffer from damage, destruction or overflow. Hence, a certain residual risk persists. Furthermore, the responsibilities for maintaining and managing structures in case of events need to be clarified to ensure effective prevention.

3.2.3 RISK GOVERNANCE AND NATURE-BASED SOLUTIONS

Nature-based solutions for natural hazard prevention follow a different logic than structural measures concerning planning and implementation. Especially protective forest functions can only be maintained by a comprehensive and diverse management including owners and local human resources. The same applies for nature-based solutions that manage run-off or soil stability. Urgent measures to restore certain biological capabilities and functions are generally publicly financed and managed.

Ecosystems do not need the same degree of maintenance as structural measures, but they evolve with time. Changes in ecosystem patterns can be a successful adaptation to shifting circumstances but might also threaten their stability and protective function. As local residents are often the first to spot such changes, they play a crucial role in the monitoring of ecological structures and systems. Their observations should be reported in regular exchange meetings with scientific and technical experts, ecosystem managers, user interest groups and public authorities on different levels.

Figure 24: Small-scale landslides in Slovenia (©Administration of the Republic of Slovenia for Civil Protection and Disaster Relief)

The perspective of risk governance in various nature-based solutions should allow involving more people, so they learn and understand the importance of such measures for hazard prevention and, if possible, take over responsibilities in long-term management. Such actions could be educational programmes or voluntary maintenance work. The Austrian Alpine Association, for example, established such a voluntary programme for mountain forests.[65]

Therefore, the following aspects can be highlighted to promote risk governance for nature-based solutions:

- *Raise the awareness* for the importance of nature-based solutions in hazard prevention by diverse educational and voluntary programmes. Such programmes should especially address children.
- *Share responsibilities among public stakeholders*, owners and local people to sustainably manage nature-based solutions with a participatory monitoring network or similar programmes.

3.2.4 RISK GOVERNANCE AND ORGANISATIONAL MEASURES

Organisational measures in hazard and risk management are strongly governance-orientated but not so much risk-based (apart from hazard insurance systems that use risk assessments for the calculation of insurance rates). This is due to the structural set-up of the responsible public authorities and the formal integration of non-governmental stakeholders, volunteers etc.

All member states of the Alpine Convention have implemented a similar scheme of a regional and/or national legislation for disaster management as a part of

65. *Further information: www.alpenverein.at/portal/berg-aktiv/freiwilligenarbeit/bergwaldprojekte.*

civil protection and installed operative institutions on a local, regional and national level. These institutions are obliged to coordinate their actions and involve specific non-governmental institutions and also private people. This structure guarantees that problems are dealt within the right scope and by the people and institutions capable of managing occurring events.

All Alpine Convention member states rely on certain operational plans on a municipal, regional or national level that define the role of authorities, rescue and relief units as well as the public in case of hazard events. The preparation of such plans implies discussions and negotiations between stakeholders about capacities and capabilities to finally be formalized in operational plans. However, disaster management has not taken risk into account on a general basis yet. Sequences could be defined for prioritizing actions in line with the damage potential to secure critical infrastructure.

Organisational measures, mainly initiated by public authorities, can also raise awareness, educate and provide relevant information on hazard and risk management. Such inclusive actions help to inform potentially affected people and to foster self-protection and responsibility.

The following aspects can be highlighted to promote risk governance for organisational measures within the Alpine Convention member states:

- *Promote risk reduction:* introduce, if not yet done, risk as an essential information for preparing emergency and contingency plans to primarily protect sensitive land uses and areas with high damage potential.
- *Ensure transparency:* make information on emergency and contingency plans generally accessible.
- *Include local people:* include local people in the preparation processes of emergency plans and assign them responsibilities to undertake effective measures in case of events to protect themselves and their properties.
- *Consider residual risk:* consider unexpected risk (structural failure, overflow etc.) for hazard prevention and preparation.
- *Appropriate insurance policies:* a possibility to share the burden of financial risks posed by natural hazards is via special insurance programmes.

ENHANCING PREPAREDNESS MEASURES

Discussing and highlighting recommendations for promoting risk governance for certain preparedness measures needs additional explanations concerning the combination of measures. Experts and authorities have changed their way of analysing natural hazards and planning measures. The modern approach aims to implement protection systems with a combination of different measures such as spatial planning, state-led planning of structural measures, nature-based solutions and organisational measures for diminishing the event scope. This leads to a situation where risk reduction can be achieved by a very broad set of possible measures. Such a system-based approach requires investigating different alternatives. Governance processes can help to perform such evaluations. They take various aspects into account but also require expert knowledge. New criteria for the selection of alternatives are necessary in such a system-based approach, and the effects of combining measures need to be evaluated. Aspects like adaptability, flexibility and coping with residual risk should be considered. Such an approach certainly increases the complexity of planning system-based measures for preparedness. However, it promotes integrated perspectives in the sense of holistic systems engineering and can create new opportunities based on the "build-back-better" principle.[66]

3.2.5 OVERALL STATUS QUO OF RISK GOVERNANCE FOR NATURAL HAZARDS

For the evaluation of a general status quo of risk governance in the field of natural hazards, it may be helpful to also have an individual look into different hazards. This assessment is based on risk mapping by EUSALP Action Group 8 in cooperation with PLANALP.

Floods

Concerning flood management, the Floods Directive[67] implies a major shift towards the implementation of more integrated measures, also considering the ecological status of rivers and establishing risk as a valuable basis in planning prevention measures. All Alpine Convention member states have a strong national policy framework and are fostering an increase in responsibility of those at risk to protect themselves. Information on areas at risk is meanwhile widely available online. Generally, multi-actor involvement and the use of a combination of different risk management measures are gaining importance. Due to the mostly regional dimension of floods, coordination on a regional level has increased, with partly voluntary settings for the

66. *PLANALP, 2014.*
67. *Directive 2007/60/EC.*

development of measures, watersheds and catchments as planning units (river contracts in Italy) or newly defined formal rules for settlements (Styria, Austria). Both analysed aspects, risk as well as governance, are already established in flood management and are gaining importance and recognition.

Avalanches
The prevention of avalanches has traditionally strongly relied on technical measures and protective forests. Effective avalanche prevention needs to involve all administrative levels (local to national) to a certain extent in all member states of the Alpine Convention. As a state responsibility, public authorities tend to provide protection, and hazard zones are well communicated to the public via online platforms. Avalanche risks are partly captured, but measures still tend to be single-instrumental and single-institutional. Especially for avalanches, it is important to have monitoring and warning systems in place which include local people and their knowledge. To manage and minimize risks, spatial planning has to take avalanche zones seriously into account. Governance mechanisms exist especially at a local level for warning and alerting.

Torrents
Torrential hazards combine floodwater with gravel transportation and predominantly affect Alpine settlements on alluvial fans. The willingness of those at risk to protect themselves is generally low, and different public authorities take care of structural prevention measures. Generally, torrential events allow only short warning periods. Such hazards can therefore be handled fairly well in terms of risk when combined with disaster management. This means that authorities in charge of structural measures and authorities for disaster management need to closely cooperate. Like the good practice example of Liechtenstein shows, this is crucial for having effective structures. Due to the local scope of torrents, some good practice examples already feature many governance aspects. The threat of events larger than design events is serious for torrential hazards. A risk-based approach is therefore needed, as well as stronger involvement of the local population. Providing information and raising awareness can be a first step in this process.

Rockfall
Rockfall events are mostly local events and normally difficult to predict. Structural measures can prevent falling rocks from reaching buildings or linear infrastructure. However, there is a need for sufficient information on the hazard process as well as coordination among local authorities, affected people and involved land owners. This can ensure the actual feasibility of countermeasures. The Alpine Convention member states have different strategies in place. There is no clear tendency concerning the consideration of risk or governance aspects. The concept of risk governance can help to develop solutions for rockfall protection on a local and consensual level while integrating spatial planning and other policies.

Landslides
Landslide protection lies within the responsibility of different administrative levels in the Alpine Convention member states. National or regional institutions as well as municipalities can be in charge of providing protection measures and prevention. Landslides tough can occur in many different forms. They might need to be tackled on an individual basis or on a large scale. The element of risk has generally not been incorporated in landslide protection, and technical countermeasures prevail. A risk governance approach based on the coordination of different authorities and involvement of the concerned local population could improve landslide protection.

It needs to be taken into account that, even after the realisation of protection measures, a certain residual risk remains. Various approaches are applied in different countries and regions, ranging from just identifying and increasing awareness to raising protection levels, thus leading to a shift in the level of residual risk. Potentially suitable concepts include identifying and communicating the residual risk as well as offering additional structural and non-structural measures to further reduce the remaining risk like personal precaution measures, evacuation planning or – last but not least – insurances. However, further efforts and discussions are needed to find suitable solutions for individual cases and stakeholders.

3.2.6 CONCLUDING ASSESSMENTS

A general statement on the status quo of natural hazard risk governance and a comparison among Alpine Convention member states are difficult to make. Governmental and administrative systems and structures differ and solutions are developed based on the specific local or regional hazard and risk situation. Risk governance always has the same objective: to facilitate a negotiation process among concerned parties to find solutions for prevention and preparation. This process should take risk perspectives into account. All Alpine Convention member states are undertaking efforts to identify gaps and weaknesses in their hazard and risk management frameworks, to slowly develop them further towards a more risk-based management and incorporate governance mechanisms and processes.

All member states are active in international projects to evaluate risk and governance orientation on different levels and to learn from comparative studies. Many authorities are already implementing multiple elements of risk governance in their activities without explicitly mentioning them.

Generally, living and coping with natural hazards in the Alps has a long tradition. On a global perspective, there is an active scientific discourse as well as substantial experience from field work. The Alps face extensive natural hazard risks, and stakeholders on all levels share responsibilities to achieve an adequately safe living environment and reduce hazard risks.

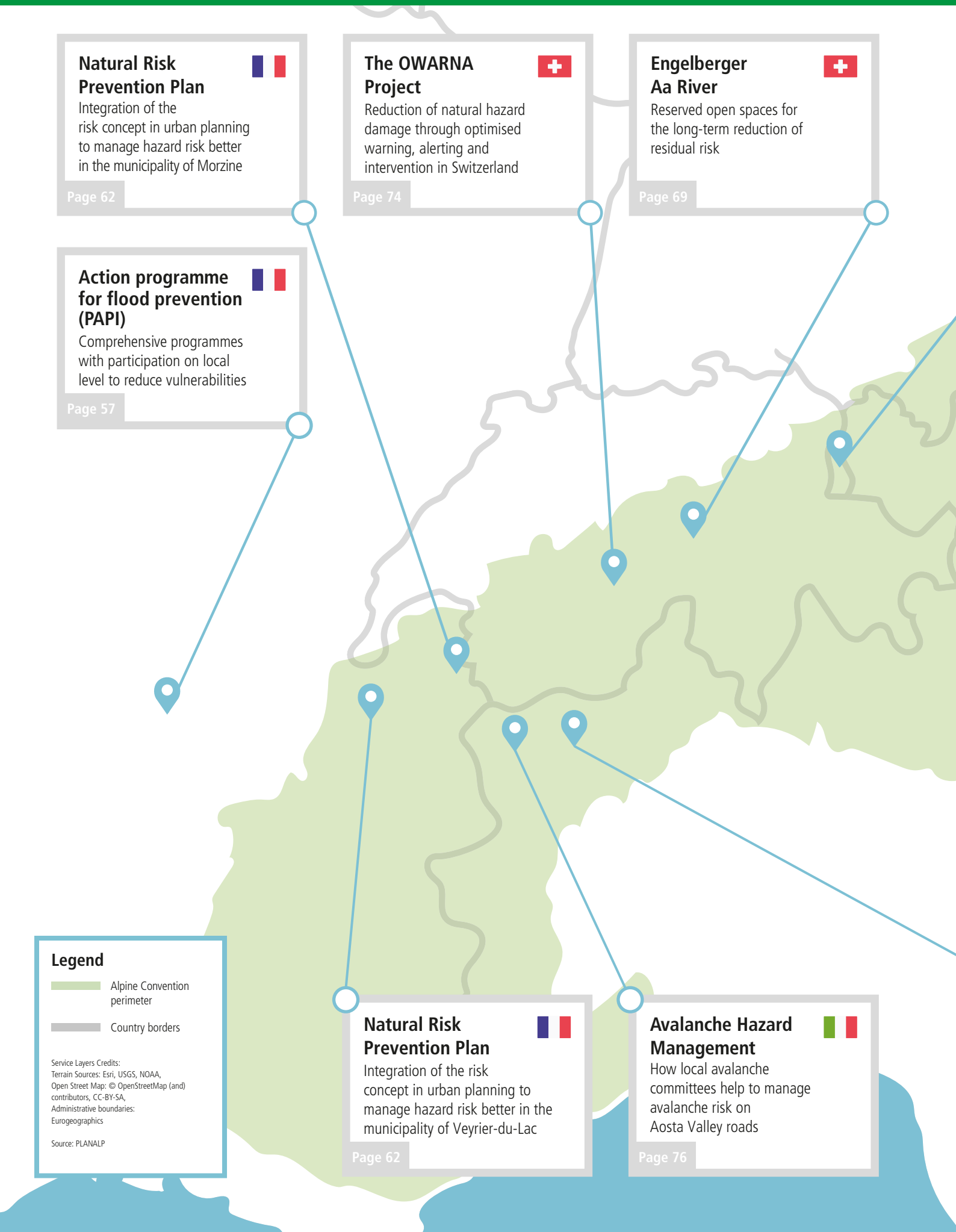
A self-assessment of the representatives from the member states in a workshop[68] revealed initial findings on the status quo of risk governance. It was stated by the representatives that *risk governance is well in place* in integrated risk management (CH), concerning catchment management and river contracts (IT), avalanche warning systems and flood prevention on the whole (DE), the flood management system (FR), hazard mapping and crisis management (LI), disaster management (SI), flood management and local avalanche protection (AT). For the question of *which natural hazard risk governance mechanisms are still missing*, the answers were also heterogeneous but with a certain consensus concerning rockfall and landslides. The hazards mentioned were flash floods and surface run-off (IT, CH), risk-based spatial planning including measures for residual risk (CH), landslides and rockfall (AT, DE, SI), fluvial floods, (AT) and avalanches (SI). For the *expected improvements by risk governance*, different aspects were mentioned: awareness of people, transnational exchange, self-protection, emergency planning (IT, CH), dialogue between prevention and crisis management (FR), implementation on a local level using local knowledge and risk reduction for society on the whole (DE), broader risk awareness (LI, FR, DE), risk perspectives instead of exclusively hazard-based perspectives (DE, LI), promoting self-protection (SI, CH), awareness and participation (AT, SI), dealing with risk on a local and regional level (AT), finding an optimal solution (Observers). Regarding the *challenges to fostering risk governance*, the following concerns were raised: coordinating the different administrative institutions and levels (IT, CH), low awareness of people (IT, CH) connection to climate change adaptation (IT), missing common understanding on a European level (IT, CH), human and financial resources (LI, FR, DE), amount of stakeholders (LI, FR, DE), complexity of governance (DE), legal restrictions (AT), institutional settings (Observers), conflicting interests (AT, SI), limits of political decision-making (AT), missing anticipatory competence (AT, SI, Observers).

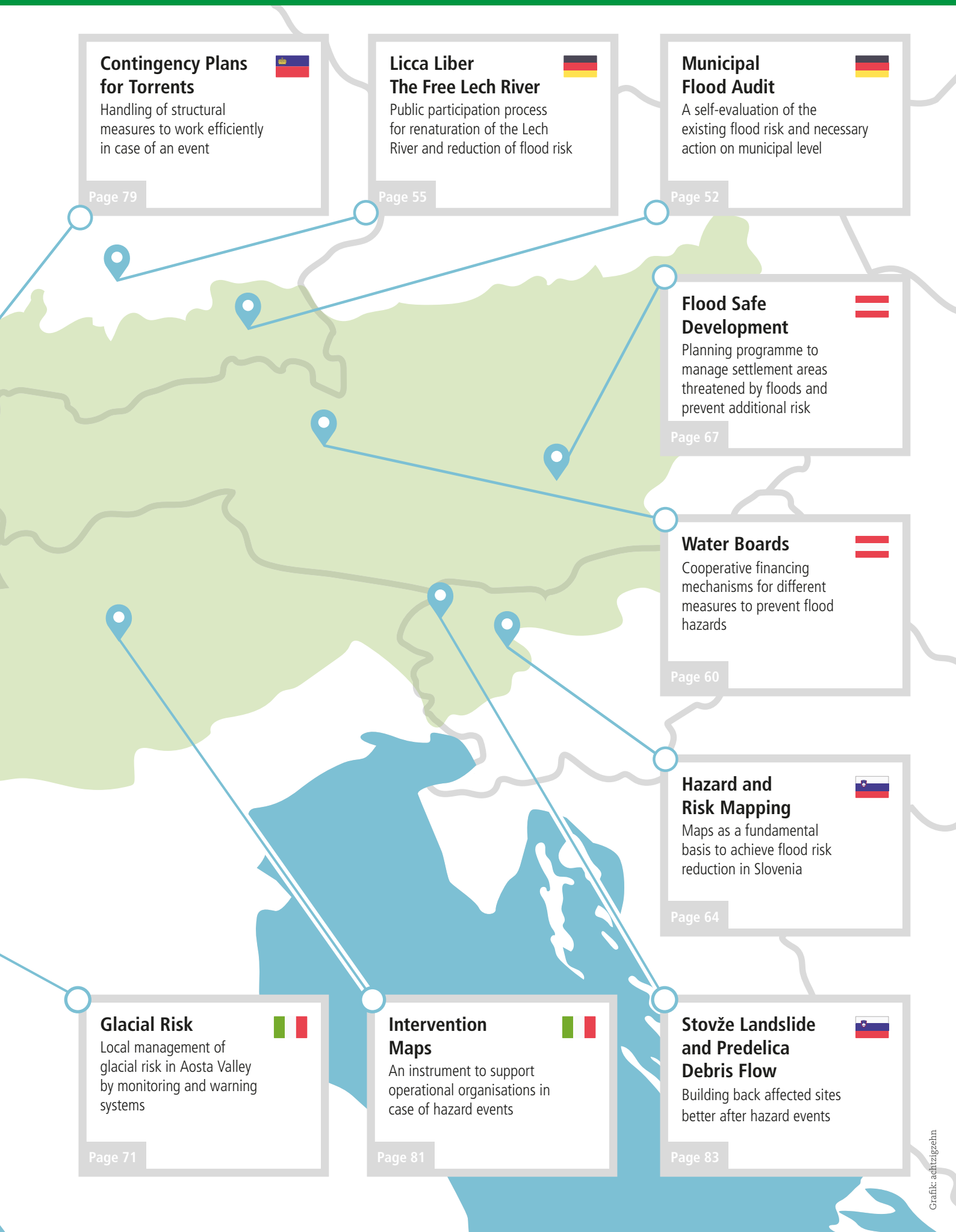
The outcome of the workshop clearly showed that the individual member states' focus and challenges vary strongly when it comes to the further development of risk management towards risk governance.

No Alpine Convention member state has actually performed a shift from risk management towards risk governance. Rather, member states are trying to further develop the way we manage natural hazard risks without throwing established procedures and regulatory frameworks overboard.

68. *Workshop of PLANALP and EUSALP AG 8 members, Innsbruck, 20.09.2017.*

MAP OF THE GOOD PRACTICE EXAMPLES





Contingency Plans for Torrents
Handling of structural measures to work efficiently in case of an event
Page 79

Licca Liber The Free Lech River
Public participation process for renaturation of the Lech River and reduction of flood risk
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Municipal Flood Audit
A self-evaluation of the existing flood risk and necessary action on municipal level
Page 52

Flood Safe Development
Planning programme to manage settlement areas threatened by floods and prevent additional risk
Page 67

Water Boards
Cooperative financing mechanisms for different measures to prevent flood hazards
Page 60

Hazard and Risk Mapping
Maps as a fundamental basis to achieve flood risk reduction in Slovenia
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Glacial Risk
Local management of glacial risk in Aosta Valley by monitoring and warning systems
Page 71

Intervention Maps
An instrument to support operational organisations in case of hazard events
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Stovže Landslide and Predelica Debris Flow
Building back affected sites better after hazard events
Page 83

Grafik: achtzigzehn

4. GOOD PRACTICE EXAMPLES

How do humans learn best? Through positive emotions and by seeing and understanding actual examples. Based on this simple principle, the 7th Report on the State of the Alps contains good practice examples for natural hazard risk governance from all member states. This set of examples shows how broad the governance concept is. Bringing relevant stakeholders together in a collaborative process to negotiate solutions for a common problem can take place within a wide variety of local to international settings. The good practice examples were consensually selected in the PLANALP working group and initial drafts for the presentation of the examples were prepared directly by the member states. Apart from a general project description, the best practice examples were evaluated for their risk governance aspects to contribute to the overall assessment of the status of risk governance concerning natural hazards in the Alps. The examples are thematically clustered. The first block consists of four contributions that focus on the *involvement of concerned local politicians and people* in the evaluation of the existing natural hazard and risk management systems as well as the development of prevention measures, their implementation and maintenance. The second block contains examples of *planning measures* undertaken on different levels to manage risks and lower vulnerabilities. Another set of good practice examples addresses *organisational measures* and especially the contingency planning as well as warning and altering. The last example comes from Slovenia, where a huge landslide and debris flow event struck a small village. The common effort of local people and public authorities was to build the village *back better* and take it as an initiative and role model for developing hazard and risk management further.

The map in the previous pages (Figure 25) shows the location of the different good practice examples scattered all over the Alpine Convention perimeter.

4.1 INCLUDING CONCERNED PEOPLE

One essential aspect of risk governance is the involvement of non-institutional stakeholders in the discussion and negotiation of solutions for hazard prevention. The four following examples demonstrate how versatile such an involvement can be.

The Communal Flood Audit in Germany helps municipalities to self-assess their preparedness and prevention measures against flood events. The Licca Liber project aims to implement a major renaturation of the Lech river based on a broad participatory process including flood issues. France has established PAPIs, a set of comprehensive strategic programmes for flood prevention on a local level, and Austria's Water Boards and Water Cooperatives are an example of successful sustainable financing of protection structures.

GERMANY

4.1.1 MUNICIPAL FLOOD AUDIT: HOW WELL ARE WE PREPARED?

A governance approach by the German Association for Water, Wastewater and Waste (DWA)

To cope with possible scenarios of rising flood risk due to climate change, limited means of protection and additional risks such as flash floods, municipalities need to think of further strategies beyond technical measures. This for example refers to raising awareness regarding the need for human resources. The German Association for Water, Wastewater and Waste (DWA) therefore developed a comprehensive audit procedure for municipalities to assess how well prepared communities are and where they need to develop further non-structural measures.

Figure 25 (previous page): Overview of the good practice examples gathered in the report (Data source: PLANALP. Author: achtzigzehn)

Principles and priorities

The municipal flood audit by the DWA has been devised because the general public – despite expert warnings – often believes that floods are controllable and technical measures guarantee complete safety. With the European Floods Directive, the legal framework was built for a paradigm shift from mere flood protection to integrated risk management. Hazard risk management is a task of the state and the public administration, but more importantly it's a task of the public to reduce potential damages. Extreme events that overload technical measures are to be considered regularly. Thus, damages in areas behind protection structures can be reduced if risk is known. With planning sovereignty at local level, municipalities have a high responsibility but also diverse possibilities of action. Here the communal flood audit helps municipalities to determine their individual need for action.

The communal flood audit is a special offer for local authorities to sustainably improve local flood prevention. It offers municipalities a possibility to comprehensively survey their flood prevention programmes independent from actual events and without time pressure. Subsequently the audit can be used to devise proper action plans to further develop municipal flood prevention programmes.

The audit can also be used as a basis for public communication of flood risks as required by the EU Floods Directive.

Content and purpose of the flood audit[69]

The municipal flood audit assesses the risk awareness of all persons involved in the audit. This includes local administrative stakeholders as well as firemen. The audit evaluates the degree of risk awareness, not the risk itself. It is expected that well informed administrative bodies as well as the general public can only react properly if the relevant information and practical solutions to minimise risk are available. The audit also deals with the implementation of reduction measures, focusing on local non-structural measures. Structural measures such as dykes, retention basins etc. are regarded as given boundary conditions but they are not subject to the evaluation itself.

Besides risks linked to fluvial floods, the audit also incorporates local flash floods which are also of great importance in the Alpine area. Due to their different boundary conditions, both hazards are considered separately in the scenarios of the audit. In line with the Floods Directive, three scenarios are taken into account: frequent floods (HQlow), floods with average probability (100-years flood, HQ100) and extreme floods (HQextr).

69. DWA, 2010.

The audit is divided in four different fields of evaluation. These are spatial prevention, technical prevention, precautionary behaviour and risk prevention.

Procedure of the audit

When the DWA receives an audit request from a municipality, it commissions a certified auditor. This auditor gets in contact with the municipality to understand which relevant stakeholders need to be integrated in the audit. For the initial audit, no specific documents are asked for. This means that the municipality generates the audit based on their own specific knowledge and information. The level of knowledge thus determines how accurate the results of the audit are.

Figure 26: Audit meeting (©German Association for Water, Wastewater and Waste)

The audit procedure usually takes two days on-site and is documented in standardised minutes. The concept is to have an active dialogue between the auditor and the relevant stakeholders of the community. These should be decision-makers and experts from the following fields: water management authority, forestry, building authority, structural engineering, health authority, civil protection, fire brigade, rescue services and many more.

At the end of the on-site visit, the auditor presents the preliminary results. A detailed documentation is then developed. Based on 35 questions the status quo of the community is clearly described. With "traffic light" graphics, the results can easily be communicated (see Figure 27). Ideally, a re-audit is commissioned after six years to map the progress made.

So far approximately 40 audits have been carried out in communities of between 1,500 to 1 million inhabitants.

The results show that municipalities are better prepared for the scenario of fluvial floods than flash floods. This might be based on the fact that flash floods have only recently gained importance in the public discussion with increasing climate change debates.

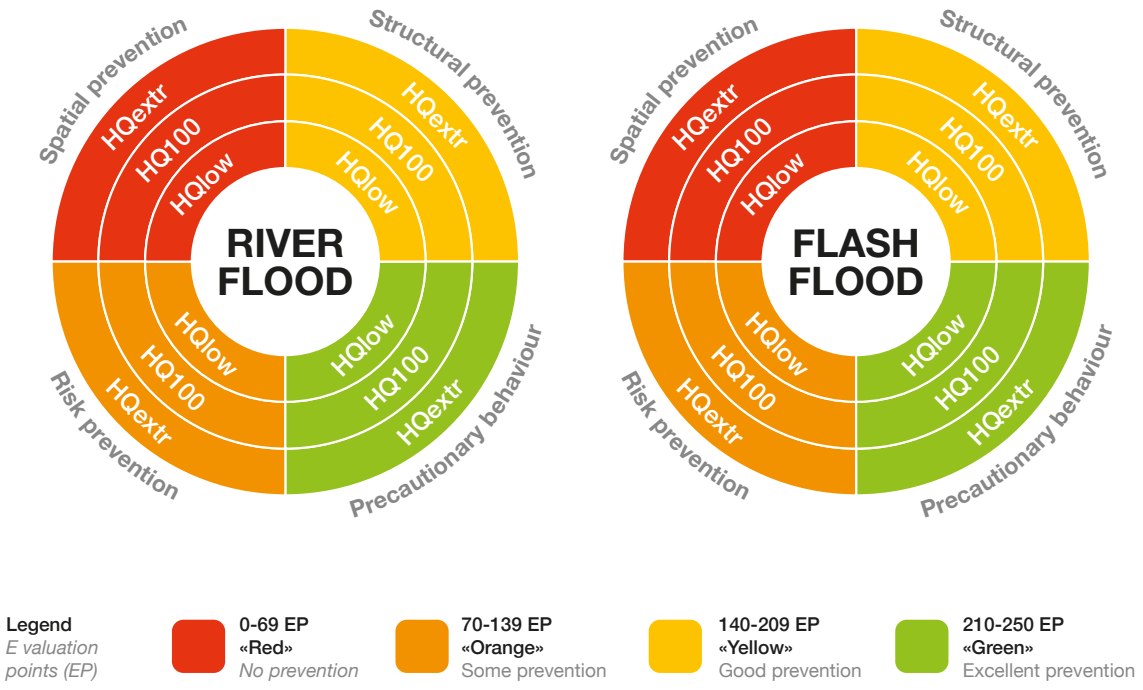

Figure 27: Exemplary "traffic light" graphics for a fictional community (Source: DWA, 2010, adaptation)

As expected, the biggest lacks in prevention were found for extreme event scenarios. This is because historically flood protection was only designed for 100-year floods. Municipalities frequently report that the audit has helped to make decision-makers more aware.

The audit is financed by the municipalities. Since late 2016, it has been subsidized by the Free State of Bavaria. It is currently being discussed whether to add the audit as a compulsory element for municipalities to get financial aid from the Free State of Bavaria for future flood protection measures.

Governance and risk governance aspects

The audit is to be understood as a helpful tool in a consultation process with the aim of strengthening the local risk awareness and consolidating integrated risk management planning systematically.

The flood audit brings together relevant actors in the process of flood protection at a local level. It aims at helping communities to identify gaps in their prevention programmes and to prioritize planned measures. Ideally, the audit will also have medium to long-term effects on a strategic level through regular re-audits.

The audit is a multi-actor instrument that includes relevant actors within municipal authorities and their administration. Thus, it is a single-level instrument that does not include individual citizens or regional bodies. It is judged as highly efficient for a first status quo analysis.

Its long-term efficiency cannot be assessed yet. Medium to long-term effects will depend on the realization of proposed measures and will have to be monitored with a re-audit.

DETAILS ON THE GERMAN MUNICIPAL FLOOD AUDIT

Institution: German Association for Water, Wastewater and Waste (*Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall – DWA*)

Link: de.dwa.de/de/hochwasseraudit.html

GERMANY

4.1.2 LICCA LIBER – THE FREE LECH RIVER

Active public participation for the renaturation of the Lech river

The Licca Liber project is a major renaturation project along the Lech river in Bavaria. To raise public acceptance of planned measures, a public participation concept was implemented based on the Austrian *Flussdialog* ("river dialogue") approach. This river dialogue consisted of four phases including workshops, a public consultation phase, the definition of development goals and a final public presentation of results. This project shows that involving important stakeholders can result in productive discussions, joint solutions and increased public acceptance of major projects.

Principles and priorities

The Licca Liber project[70] is a major river restoration project in the Free State of Bavaria along the Lech river. The project aims to stop the progressive degradation of the river bed due to erosion. Additionally, a "good ecological potential"[71], as defined by the European Water Framework Directive, has to be achieved. The project also creates synergies by ensuring nature conservation and providing recreation areas. The project started in 2013 and is managed by the Free State of Bavaria, with the *Donauwörth* water management authority as the coordinating body. The project area is situated between hydropower plant 23 south of Augsburg and the confluence of the Lech and the Danube. Several planning sections will be realized successively.

Figure 28: Location of the Licca Liber project in Bavaria (©Bavarian Surveying Administration)

For the first section between hydropower plant 23 and the city of Augsburg, it was decided that an active form of public participation is desired and needed. The reason for that was the high groundwater level in the cities on both riversides, where inhabitants were worrying about negative impacts. The water supply of Augsburg today is based on the canalized river course. Several wells close to the river provide Augsburg with drinking water. On both sides of the river, there are protected Natura 2000 areas, where the concept of "no deterioration" must be considered. Furthermore, protected forests have to be conserved in quality and size by law. Even for high water levels, the former alluvial forest no longer interacts with the river. Other factors are recreation zones in the surroundings of the Lech and hydropower generation.

All these different interests and uses of the Lech river need to be integrated into a concept to fulfil the above-mentioned aims. By basing the concept on public participation, the water management authority hopes to increase awareness and tolerance for hydrological measures.

The process of public participation[72]

The overall aim of the public dialogue was to formulate and agree on river development goals and to create a common understanding of different perspectives and requirements. The stakeholders and residents participated through an information and consultation process. Stakeholders from the following fields were involved: nature conservation, fishery, forests, municipalities, mayors, state parliament members, public administration, tourism and water suppliers.

The participation process increased awareness and tolerance for hydraulic measures, water ecology, flood protection and water usage. Additionally, it served as an orientation for politics, authorities and stakeholders.

In the first phase, workshops with all the different stakeholders were organized. These workshops collected the different positions and ideas of stakeholders. Finally, the participants of the workshops agreed on the questions for public consultation.

70. *Further information: www.wwa-don.bayern.de/fluesse_seen/massnahmen/liccaliber/index.htm.*
71. *Directive 2000/60/EC, Water Framework Directive.*
72. *Winter, 2016.*

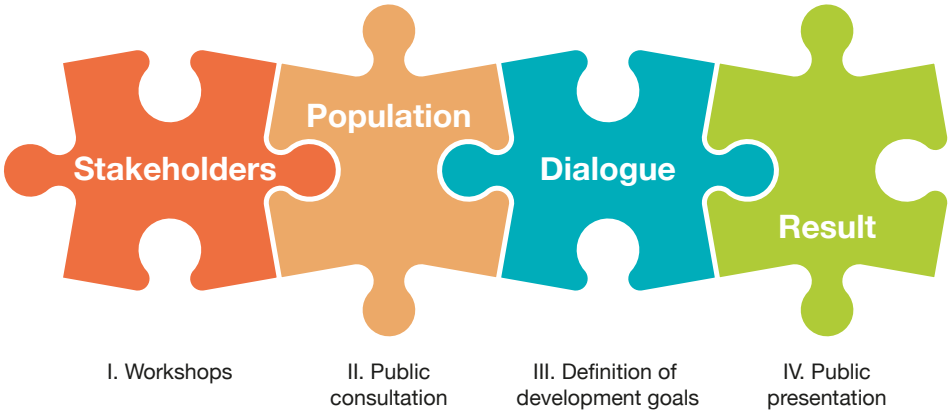

Figure 29: The four phases of public participation work together like a puzzle (©Water Management Office Donauwörth, adaptation)

This laid the foundation for the second phase, in which an online survey was conducted between January and February 2014. The online survey dealt with the topics of renaturation, recreation zones, integration of nearby lakes, hydropower generation and public funding. Around 6,800 citizens of the surrounding municipalities participated. More men than women answered the questions and the generation 50+ was overrepresented. There was a broad consensus about rebuilding a near-natural stream course and for the preservation and development of habitats and species. A negative attitude was shown towards the relocation of wells and hydropower usage. The integration of lakes was seen controversially. Here, regional differences became apparent.

In the third step, river development goals were defined as a result of the workshops and of the online survey. These goals aim at (i) preventing further degradation of the river bed; (ii) fostering a stable environment for fish and gravel; (iii) creating new meadows and habitats; (iv) maintaining and improving flood protection; (v) preventing increasing levels of ground water in villages; and (vi) enhancing accessibility and local recreation. All stakeholders brought a symbol to the meeting to illustrate what they associated with the Lech river and to document their final agreement on the development goals (see Figure 30).

Figure 30: Final agreement on the development goals (©Water Management Office Donauwörth)

The fourth phase comprised a public presentation and fair booths of the different stakeholders to inform the population about the process, the resulting development goals and further steps.

Based on the development goals, the administration formulated an implementation concept for the renaturation of the Lech River. The public participation clearly showed that everybody wanted a change for the Lech.

The public participation now continues through the Licca Liber working group, the Licca Liber forum and the Licca Liber newsletter.

An interesting result of the process was that in the end not the leading water resources administration was asked about consequences of ideas or scenarios. Instead, the different users and stakeholders themselves answered the questions. For example, the drinking water company explained what the renaturation idea of a nature conservation organisation would mean for the drinking water supply. These direct explanations found much more acceptance.

Governance and public participation

The Licca Liber project was based on wide public participation to ensure a smooth and transparent project planning phase. Therefore, multiple stakeholders were integrated in the process. Furthermore, a river dialogue was used to inform people and raise public awareness on flood protection measures, hydraulic engineering measures, nature conservation, hydropower use and water ecology. Moreover, the interaction between the different interests and the resulting restrictions were actively discussed in the workshop.

Experiences show that the involvement of stakeholders

and the population is decisive. The workshops give room to stakeholders to introduce and exchange their ideas. The online survey gives a clear picture of how the population perceives the Lech river as it represents the silent majority.

This project is a good example of risk governance on a local and regional level. Selected elements might serve as a good practice example for further project sections of the overall Licca Liber project. The results of the river dialogue also have long-term strategic effects on the future progress in transforming the Lech River.

The evaluation of the public participation process showed that it was a multi-level, multi-actor process, involving local people via online survey.

A study is currently evaluating if the measures defined in the realization concept can be technically achieved. Therefore, all available data is used to model different approaches for stabilizing the Lech river and for ensuring flood protection. The study also assesses whether the good ecological potential required by the European Water Framework Directive will be accomplished.

DETAILS ON THE LICCA LIBER PROJECT

Institution: Water Management Office Donauwörth (*Wasserwirtschaftsamt Donauwörth*)

Link: www.wwa-don.bayern.de/fluesse_seen/massnahmen/liccaliber/index.html

FRANCE

4.1.3 ACTION PROGRAMMES FOR FLOOD PREVENTION (PAPI)

A tool for a comprehensive prevention strategy

In France, the Action programmes for flood prevention (*Programmes d'action de prévention des inondations* – PAPI) are led by local authorities and aim at generally reducing the vulnerability of areas exposed to flood risks. PAPIs cover areas with consistent risk potential and can deal with different kinds of flood risks. The actions cover all aspects of the flood risk management policy. These Action programmes are based on national specifications established by the state and are certified either by the Joint Flood Commission (CMI) or by the authorities within the respective catchment basin, depending on the programme budget. Certification allows the local authorities to benefit from financial support from the prevention fund for major natural hazards (FPRNM). PAPIs are an agreement signed between the local authority implementing the project, the state and the primary financing partners. A steering committee and a technical committee ensure the management and monitoring of the implementation of such programmes. New national specifications applicable since 2018, called PAPI 3, provide a number of additional requirements designed to improve the implementation conditions for these programmes.

Principles and priorities[73]

Floods represent the most important natural hazard in France. It is currently estimated that 17 million people in France live in areas exposed to the risk of flooding, in other words one in four inhabitants. Additionally, the average annual cost incurred by damage caused by floods in France that is covered by the national natural disaster solidarity fund is estimated to be around 400 million euros per year.

The objective of the Action programmes for flood prevention is to take a holistic approach to reducing the vulnerability of areas exposed to flooding. PAPIs are the preferred method for operational implementation of local flood risk management strategies developed for each significant flood risk area (TRI) under the 2007 Floods Directive. But PAPIs may also be provided outside the context of local flood risk management strategies.

73. *The PAPI specifications are available on the Ministry of Ecological and Social Transition website: www.ecologique-solidaire.gouv.fr/prevention-des-inondations, 13.03.2018.*

The PAPI scheme aims to promote Action programmes:

- led by local authorities or groups of such authorities;
- applied in an area with coherent flooding risks;
- based on a rigorous diagnosis of the area's potential flood risks;
- making use of a strategy shared with the area's various stakeholders and the general public;
- seeking consistency with other public policies, especially territorial and urban planning as well as the preservation of aquatic environments;
- bringing together the various aspects of flood risk management policy, particularly non-structural actions;
- proportionate to the area's particular challenges and potential PAPI impact;
- based on transparently discussed decisions and objective criteria;
- for which the various implementation steps (public sector contracts, operational studies, environmental authorisation, land acquisition etc.) have been anticipated to optimise their application in the field after certification and to ensure practicability within the PAPI implementation time frame.

PAPIs must comply with national specifications. To ensure such compliance, PAPIs are certified by the CMI for projects with an amount above or equal to 3 million euros, excluding taxes. In other cases, PAPIs are certified by basin authorities. Certification allows the local authorities to benefit from state subsidies and from financial support from the fund for the prevention of major natural hazards.

So-called "Proposed PAPI" programmes allow local authorities to get state and FPRNM financing for the studies necessary for the preparation of a full PAPI programme.

The new 2018 PAPI 3 specifications seek to take into account the lessons learned from PAPIs certified since 2011, in particular regarding the improvement of implementation conditions for Action programmes.

The content and role of PAPIs

A PAPI programme comprises the following principal elements:

(1) presentation of the project owner (statute, experience in the water and flood management field);
(2) a comprehensive and shared diagnosis of the area with regard to flooding risk;
(3) a coherent strategy for the identified problems, based on analysis of the area concerned, and presenting the proposed objectives. It lists the measures to be implemented covering all aspects of the specifications;
(4) a section dedicated to governance: this details the project's terms with regard to local governance and the interface with water management procedures, as well as territorial planning policies;
(5) a note on risk integration in territorial and urban planning;
(6) the comprehensive and interdisciplinary action programme, as well as the schedule and financing plan;
(7) the multi-criteria analysis and/or the cost-benefit analysis for works related to dykes and water flow management (dynamic slowdown works, watercourse recalibration, rehabilitation of natural flood expansion zones etc.);
(8) the PAPI's environmental analysis.

The actions set forth in the Action programme must be initiated within a six-year period covered by the framework agreement. However, amendments to the original agreement are possible. Amendments questioning the overall nature of the initial programme must be re-certified.

Example: the Brévenne-Turdine PAPI

The Brévenne-Turdine PAPI was certified by the CMI on 12 July 2012. This PAPI led by the Brévenne-Turdine river Managing Body amounted to 10.2 million euros, with state support at 156,000 euros and FPRNM support at 5 million euros. The other financing partners were the Région Rhône-Alpes (11%) and the Rhône departmental council (10%). The rest of the project was financed directly by the project owner.

The Brévenne catchment basin is located in the Rhône department between the Monts du Lyonnais and the Monts du Beaujolais. The Brévenne is the last major tributary of the Azergues, which is a tributary of the Saône. The Brévenne's main tributary is the Turdine. The almost 400 km^2 the Brévenne-Turdine catchment basin contains nearly 160 km of watercourses. A total of 66,000 inhabitants are exposed to the floods in this catchment basin.

As a continuation of work carried out in this area relating to the management of the aquatic environment, the Brévenne-Turdine PAPI management preferred natural solutions and wished to minimise any impact on the aquatic environment. As the basin did not originally include a dyke, the decision was made not to build one. The programme was therefore based on the principle of accepting overflows in designated areas and on a return to natural watercourse functioning.

The chosen strategy therefore had to focus on reducing the risk for the population: implementing communication campaigns (sharing the flood risk prevention plan, organising a fair every other year, defining a family safety plan, and free vulnerability assessment for inhabitants), raising awareness amongst elected representatives who would act as a relay, setting up a "sentry" network with voluntary residents who would send out information or alerts etc.

The area's vulnerability has thus decreased but, more importantly, awareness of the risk itself has significantly improved. A decisive factor in the choice of actions has been consultations and discussions with local people and agricultural stakeholders, taking an open, constructive approach instead of an informative one.

The river managing body appointed a mediation firm and was able to count on local mayors being heavily involved, facilitating links with the local population.

Certain modifications were made to the programme during the course of its implementation: deciding on two flow management units out of the initial five, reducing land impact, use of natural materials, intentional flooding of certain areas to protect those downstream and increased action relating to rainwater runoff. The practicability of these changes was then reassessed.

Governance and risk governance aspects

The national flood risk management policy is discussed within a national decision-making body, the CMI. This body brings together national and local elected representatives, representatives from civil society, various qualified persons as well as state representatives.

The new PAPI 3 national specifications were drawn up by a national working group that included members of the CMI.

The primary source of funding for PAPIs is the fund for the prevention of major natural hazards. This fund is financed by a levy on insurance premiums or additional contributions relative to the guarantee against the risk of natural disasters, as defined in the French insurance code. For each PAPI, the Action programme's management and monitoring are carried out by a Steering committee that is supported by a Technical committee.

The Steering committee guarantees the PAPI project's proper implementation as well as the achievement of the objectives that were validated by the certifying body. The agreement relating to the particular PAPI provides the management framework. The signatories coordinate their action within the steering committee, which meets periodically. The Steering committee comprises representatives of the financing partners, contractors and the state. It is jointly chaired by the state's representative and the project leader's representative. It meets at least once a year.

The Steering committee verifies the progress of the Action programme's various components and also makes sure that the programme is consistent during the various annual stages of implementation. In particular, it monitors the indicators intended to enable assessment of the effectiveness of actions that are carried out.

The Technical committee is responsible for the technical monitoring of the project's actions. It is composed of officials who are appointed respectively by the representatives of the financing partners, the contractors and the state. It informs the Steering committee of the progress of the implementation of the Action programme, any indicator developments and any difficulties arising during implementation. It ensures the implementation of decisions made by the Steering committee.

Additionally, the PAPI Administrative and Financial Monitoring (SAFPA) web tool enables national monitoring of PAPIs with regard to the physical progress of actions and the monitoring of the use of state and FPRNM credits.

Concerning risk governance aspects, the Action programmes for flood protection focus on a holistic catchment-based approach and take risk and vulnerability closely into account. At the same time, public institutions as well as the local communities and people are included in this still quite formal and state-framed process. The programmes require immense efforts concerning the coordination and actual implementation of measures. Nevertheless, successful examples support the chosen approach and foster governance processes in flood risk management.

DETAILS ON THE BREVENNE-TURBINE PAPI

Institution: Brévenne-Turdine River Managing Body (*Syndicat de rivières Brévenne Turdine*)

Link: www.rhone.gouv.fr/Politiques-publiques/Securite-et-protection-de-la-population/La-securite-civile/Les-risques-majeurs/Les-risques-majeurs-dans-le-Rhone/Les-Programmes-d-actions-de-prevention-des-inondations-PAPI/Les-PAPI-dans-le-Rhone/PAPI-Brevenne-Turdine

4.1.4 WATER BOARDS

A cooperative financing mechanism based on the solidarity principle

Water boards and cooperatives (according to the Austrian Water Act) are an alternative form of financing and maintaining protection measures for flood, torrent and avalanche control in Austria. They are based on the principle of solidarity and can be regarded as a cooperative regulation model within the framework of risk governance. Water boards and cooperatives offer ample possibilities in the design of autonomous decision-making processes and internal conflict resolution in the context of hazard protection projects.

Principles and priorities

Cooperative financing mechanisms are one way of boosting resilience to natural hazards in Austria. They also tackle the question of increased privatisation of risk. This includes a stronger engagement of non-governmental actors such as private households and businesses to increase investments in self-protection and also to increase risk awareness and perception.

In Austria, municipalities are normally the promoters of projects for the protection from torrents and avalanches. However, according to the Austrian Water Act 1959, a water board or cooperative can also function as an initiator and operator of protection measures.

A water board (or cooperative) is a legal body composed of individuals, municipalities, companies etc. The tasks of these statuary bodies include sharing of (financial) risk associated with water-related hazards at a specific site – mainly valleys and regions – as well as the maintenance of the structures. Each member financially contributes to a common fund, which is devoted to developing mitigation or prevention measures. The underlying idea is to share risks and financial burdens, e.g. to develop protection measures in a torrent or river with all stakeholders and organisations wanting to achieve a certain safety level in a region – regardless of whether they are directly affected by the actual hazards.

Structure of water boards and cooperatives[74]

Water boards and cooperatives all have a similar structure and have to meet certain legal requirements, such as:

- a minimum of three partners;
- a manager or a managing committee;
- a chair and a deputy;
- (regular) assemblies.

The statutes of water boards and cooperatives define the area of the statutory body, criteria for membership, voting rights and principles for cost-sharing among members. They also include precaution measures for mediation to resolve

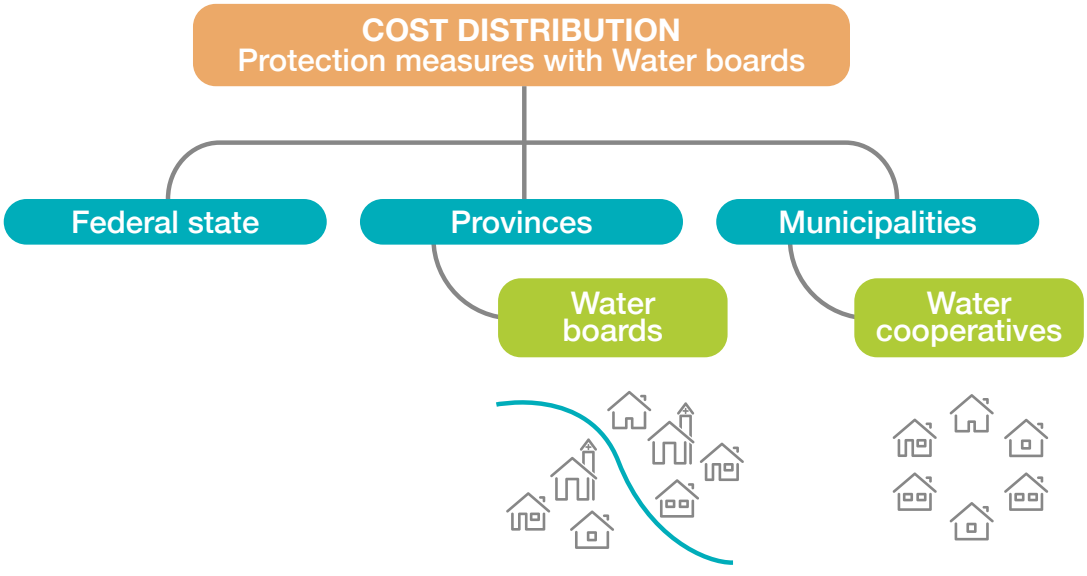

Figure 31: Cost distribution of protection measures (©Federal Ministry for Sustainability and Tourism, Austria; and Schindelegger)

74. Rudolf-Miklau et al., 2015.

potential conflicts among the members or between the members and the water board.

Water boards can be founded through a voluntary consolidation of stakeholders, a majority decision with concurrent involvement of resistant minorities or by decree of the provincial governor (enforced water board).

Water boards and cooperatives – status quo

In Austria, the system of water boards for torrent and avalanche control is only common in the province of Salzburg, where 230 water boards for torrents have been established to date. Among these, there is only one "enforced" body (see above definition).

Detailed statistical data on the boards and cooperatives are only available for the Pinzgau district, where 103 cooperatives boards exist. These data are detailed in the following table.

Number of members	3 - 630 (average 109)
Average contribution of Water board to project costs	20.5% (max. 28%)
Average member contribution	€ 2,500 – 7,000

Table 1: Statistical data on water boards in the Pinzgau district, Austria (©Survey of Austrian Service for Torrent and Avalanche Control, 2015)

In 2014, water boards (and intermunicipal cooperatives) contributed approximately 5.5 million euros to measures of the Austrian Service for Torrent and Avalanche Control in Austria.

Governance aspects

Communities are often restrained by necessary building restrictions in endangered areas. Municipalities have to ensure safe living conditions but also promote regional development. In the municipal risk management, public instruments face certain limitations and can be substituted by cooperative processes, especially for decision-making. Therefore, cooperatives can be regarded as a regulatory model of risk governance. Their form is self-administrated

Figure 32: Water Board Day of the Pinzgau torrent water boards (©Die. wildbach)

in water management with participative character. This means that rules are set autonomously, decisions are made democratically and conflicting interests are solved internally.

The foundation of water boards and cooperatives usually involves all owners of benefiting properties. The membership is bound to the property. This ensures reliable financing and sustainable maintenance of the measures. The rules and regulations can be adapted to the needs and relations of the members, always based on the minimum set described above.

The funds for activities and purposes of the water associations or cooperatives are raised based on the solidarity principle and the contributions are based on how big the gained advantage or reduced disadvantage is. The decision-making process within the water board or cooperative is based on democratic principles or on an autonomous set of rules agreed upon in the statutes.

Controversies are normally regulated by a conciliation body defined in the statutes.

To summarize, water boards and cooperatives are groups of interest comprising multiple stakeholders with a high degree of self-determination on a democratic basis defining rules and regulations. In natural hazard protection projects, these groups of interest can enhance local awareness and knowledge, while also increasing acceptance of measures.

DETAILS ON THE WATER BOARDS PROJECT

Institution: Federal Ministry of Sustainability and Tourism (*Bundesministerium für Nachhaltigkeit und Tourismus – BMNT*)

Link: www.naturgefahren.at

4.2 RISK GOVERNANCE IN PLANNING MEASURES

Residential and infrastructure development must consider natural hazard risks. Strategic and holistic long-term perspectives need to form the basis of planning decisions to increase resilience and minimise exposure. Planning measures interact closely with structural, nature-based and organisational measures and can guide future development. Precaution by area, especially for areas with protective functions such as flood plains or protective forest, is of paramount importance. France has devised the Natural Risk Prevention Plan, a tool to develop not only effective protection measures but also incorporate planning guidelines for future development to keep restricted areas free and other areas developed in a hazard-adjusted manner. Slovenia just recently (2007) started with its comprehensive flood hazard and risk mapping activities. The various systems have evolved very quickly due to the necessities of the Floods Directive and have also brought major changes for planning activities. An example from the Austrian province of Styria presents a regional planning programme that ensures that development is safe from floods. It also incorporates risk management elements. The Swiss example of the Engelberger Aa river is an integrated flood protection measure showcasing various risk governance aspects by combining planning, technical and organisational measures to reduce flood risk in an integrated way. Reserved open spaces are used for flood overspill to be discharged without any damage to the lake. A last example comes from the Italian Province of Aosta Valley, where glacial risks are managed locally in an integrative manner.

FRANCE

4.2.1 NATURAL HAZARD RISK PREVENTION PLAN

A tool for a comprehensive prevention strategy

The PPRN is a tool within the state's natural hazard risk prevention policy in France. Its aim is to fully control urbanisation in risk zones and reduce the vulnerability of people and existing structures.

Principles and priorities

More than half of the French municipalities are exposed to natural hazard risk to varying degrees. These result from a combination of one or more hazards (flooding, rockfall, landslides, cave collapse, earthquakes, avalanches, forest fires etc.) and existing local features (people, property, activities, resources, natural and urban heritage features that are likely to be affected by a natural phenomenon). It is within this context that the Law on Strengthening Environmental Protection passed in 1995 provides the state with a regulatory tool that is dedicated to the prevention of risks: the Natural Hazard Risk Prevention Plan.

The PPRN's aim, with sustainable development in mind, is to prevent people and properties from being increasingly exposed to natural hazard risks and to reduce the negative impact of natural hazards on human lives, the environment, economic activity and cultural heritage:

- The PPRN contributes to decreasing exposure to natural hazards by defining high risk zones where buildings or other facilities are prohibited, and by allowing other zones to be developed in a thought-out and safe manner complying with certain requirements in line with the potential hazard intensity (medium or low).
- The PPRN contributes to the reduction of potential damage by defining prevention, protection and conservation measures, alongside measures relating to the development or use of buildings, civil engineering structures, and agricultural areas existing on the date of the plan's establishment.

Figure 33: Rockfall in Morzine, Upper Savoy, 2013 (©National Forests Office, Land Restoration in Mountains)

The contents and role of a PPRN

A PPRN consists of three documents:

- *A project outline:* this indicates the geographical area concerned, the nature of the natural phenomena in question and their possible consequences based on the current state of knowledge. It justifies preventive choices made, indicating the principles governing the PPRN's development and explaining the regulations in place.
- *A regulatory zoning plan:* this zoning plan combines information from the hazard map and the stakes' map to define the zones regulated by the PPRN. These are the current zones at risk, but also zones where development could aggravate the existing risks or cause new ones. The hazard map characterizes the phenomena to which the risk area is exposed and determines a reference hazard. This makes it possible to locate and classify the various hazard zones. The stakes are assessed qualitatively regarding land use and occupation patterns.
- *A regulation:* this regulation specifies the rules applicable to each of the zones. It therefore defines the conditions in which any construction, civil engineering works, developments and agricultural, forestry, artisanal, commercial or industrial operations are to be carried out. It also regulates the preventive, protective and conservation measures for which individuals or local authorities are responsible, but also any mandatory measures applicable to existing property and activities.

The methodology regarding the development of risk prevention plans is described in a general guide and the specificities regarding the particular hazards dealt with are found in thematic guides.

As the PPRN represents a public utility easement, it is attached to any urban planning document. It applies to everyone: individuals, businesses, local authorities and the state. It can deal with a single type of risk or with several and may extend over one or more communes.

Example: a rockfall risk prevention plan

For the development of a rockfall risk prevention plan, the estimation of risk is based on the analysis of phenomena likely to occur at any given point with a given intensity. This hazard includes a range of phenomena ranging from a single rockfall event to large scale phenomena.

There are several steps necessary prior to establishing zoning regulations:

- defining the risk area and the scope of the study;
- identifying and describing past and current phenomena: bibliographic survey, use of databases, aerial photographs, thematic maps, land surveys, personal accounts;

Figure 34: Regulatory zoning, Veyrier-du-Lac PPRN (© French National Forests Office, Land Restoration in Mountains)

- qualifying hazards in terms of intensity (defined according to physical parameters or a damage potential scale) and definition of reference scenarios (plausible within 100 years);
- creating a "hazard map" (1:10,000 scale) demarcating homogeneous hazard zones;
- evaluating features that are at risk.

Governance and risk governance aspects

PPRNs are established for the most exposed areas under the authority of the department prefect. Their development is financed by the state through the fund for the prevention of major natural hazards. PPRNs are carried out within an involving and consultative framework together with the regional and local authorities in charge.

Involvement is essential for public action to be effective. It creates the trusting climate necessary for accepting the analyses and decisions that form the basis of the PPRN project. The various stakeholders –particularly regional and local authorities responsible for territorial planning – are therefore involved from the very beginning of the process, mostly through meetings.

Consulting the general public is a fundamental success factor and should be done as comprehensively as possible. The objective is for the process to be shared by everyone concerned. It allows for an open debate and public discussion between the various players on a project that affects the area and the local population. Public consultation can take several forms (public meetings, websites, discussion forums, town hall registers etc.) and is particularly effective during the following stages:

- first discussions;
- hazard, stakes, and vulnerability studies;
- local preventive strategy and PPRN project.

Official authorisation is given after conducting a public inquiry. Then, the PPRN must be approved (and authorised by the prefect) within a period of three years, extendable once with an 18-month limit.

To conclude, the PPRN is an operational tool that has been available since 1995 with the aim of reconciling development and risk, while reducing the vulnerability of people and property. It requires a coherent approach involving all stakeholders (state, regional and local authorities, civil society etc.) and a consultative and instructive spirit. The involvement of the public is a fundamental factor to ensure that the plans are accepted by the local stakeholders and public. This approach should lead to a suitable formulation of the PPRN's regulatory requirements, so as not to hinder urbanisation unnecessarily. These requirements should also ensure suitable construction conditions in risk zones, taking into account the local landscape and architecture whilst respecting the preventive objectives that have been set. The existence of a PPRN also creates opportunities for financing and subsidies – especially for local authorities – to reduce vulnerability.

DETAILS ON THE RISK PREVENTION PLANS OF THE MUNICIPALITIES OF MORZINE AND VEYRIER-DU-LAC (UPPER SAVOY)

Institution: Departmental Land Use Direction of Upper Savoy (*Direction Départementale des Territoires de la Haute-Savoie – DDT*)

Link: www.haute-savoie.gouv.fr/Politiques-publiques/Environnement-risques-naturels-et-technologiques/Prevention-des-risques-naturels/Donnees-communales-plans-de-prevention-des-risques-naturels

SLOVENIA

4.2.2 FLOOD HAZARD AND RISK MAPPING IN SLOVENIA

A fundamental basis for national and local flood risk reduction

The European Floods Directive constitutes an important improvement for the reduction of flood risks, introducing the principle of flood risk management on a supranational level. The provisions of the directive were transposed into Slovenian national law by adopting amendments to the Water Act as well as decrees on the establishment of flood-risk management plans and on the conditions and limitations for construction and activities in flood-risk areas. Together with the methodological rules defining flood risk and flood-related erosion areas in 2007, these regulations form an effective legal framework in Slovenia to prevent an increase in damage potential in flood risk areas. For the purposes of flood hazard mapping, 10-year floods (high probability scenario), 100-year floods (medium probability scenario) and 500-year floods (low probability scenario) were chosen for the classification. All Slovenian flood hazard and flood risk maps are publicly accessible and downloadable via the *eWater* web portal or the Slovenian Water Management Atlas. Such maps have an important role in local awareness raising and informing affected people about hazard zones and risks.

Principles and priorities

Preventive flood risk management creates retention areas to reduce damage potential and flood extent. It also limits construction in flood-prone areas and thus avoids additional damage potential. Since 2008, Slovenia has been achieving this through legal restrictions for public or private investments by limiting different types of construction activities in flood risk areas. The legal decree on the conditions and limitations for construction and activities in flood risk areas presumes that, in case of changed hydrological conditions, compensatory measures must be provided to maintain the retention capacity and not to worsen the hydrological situation downstream.

This legal approach has been applied in municipal planning. Therefore, required spatial data is continuously provided by hydrologic and hydraulic studies conducted by investors in line with the Floods Directive as well as national legislation. The state and the municipalities, as well as private investors are obliged to map the flood hazard classes when preparing spatial planning documents or projects for obtaining water

and building permits if the area of interest is located in a floodplain.

Flood hazard and risk maps are an important basis for the Flood Risk Management Plan for Slovenia, which addresses the flood risk in 61 areas with potentially significant flood risk. Slovenia's flood risk management plan therefore includes 17 detailed plans which are logically (inter)connected and include a detailed identification and prioritisation of the necessary flood protection measures that have already been going on or still have to be implemented. The flood protection measures were chosen from Slovenia's catalogue of flood protection measures, which consists of 20 such measures. Furthermore, the flood protection measures are divided into flood protection projects.

The first version of the National Disaster Risk Assessment drafted in 2015 presents and evaluates the risks for 12 disasters and shows that floods represent the highest risk in the Republic of Slovenia. These findings stress how important it is to seize all opportunities to properly manage and reduce flood risk. Slovenia has had approximately 100-150 million euros of annual flood-related damages in the last 25 years. Flood hazard and risk maps already contribute to more effective preparedness and response phases, as well as a more effective prevention phase.

Lessons learned from 2007-2017

In Slovenia, decisions on whether and how to allow construction are based on studies. Prior to 2007, Slovenia had no official methodology on how to prepare flood hazard or risk maps. In the 2008-2015 period, over 300 hydrologic and/or hydraulic studies on modelling water depth and speed were made and certified for more than 1,000 km^2 of valid result areas. Data from studies are collected as geodata layers and published in the Atlas of Waters for Q10, Q100 and Q500, four hazard classes, and three water depth classes for Q100.[75]

Regulations define the methods and criteria for the classification of land into flood and erosion risk classes. They determine which spatial interventions are permitted or prohibited depending on the corresponding hazard classes in flood-prone areas.

Protection against the adverse effects of water in risk areas should be provided by state and local authorities. The state is basically responsible for the protection of people, the environment, economic activities and cultural heritage. In periods of increased risk it should ensure the implementation of emergency measures. Landowners in landslide-prone areas are limited in their property owners' rights and are not allowed to freely intervene

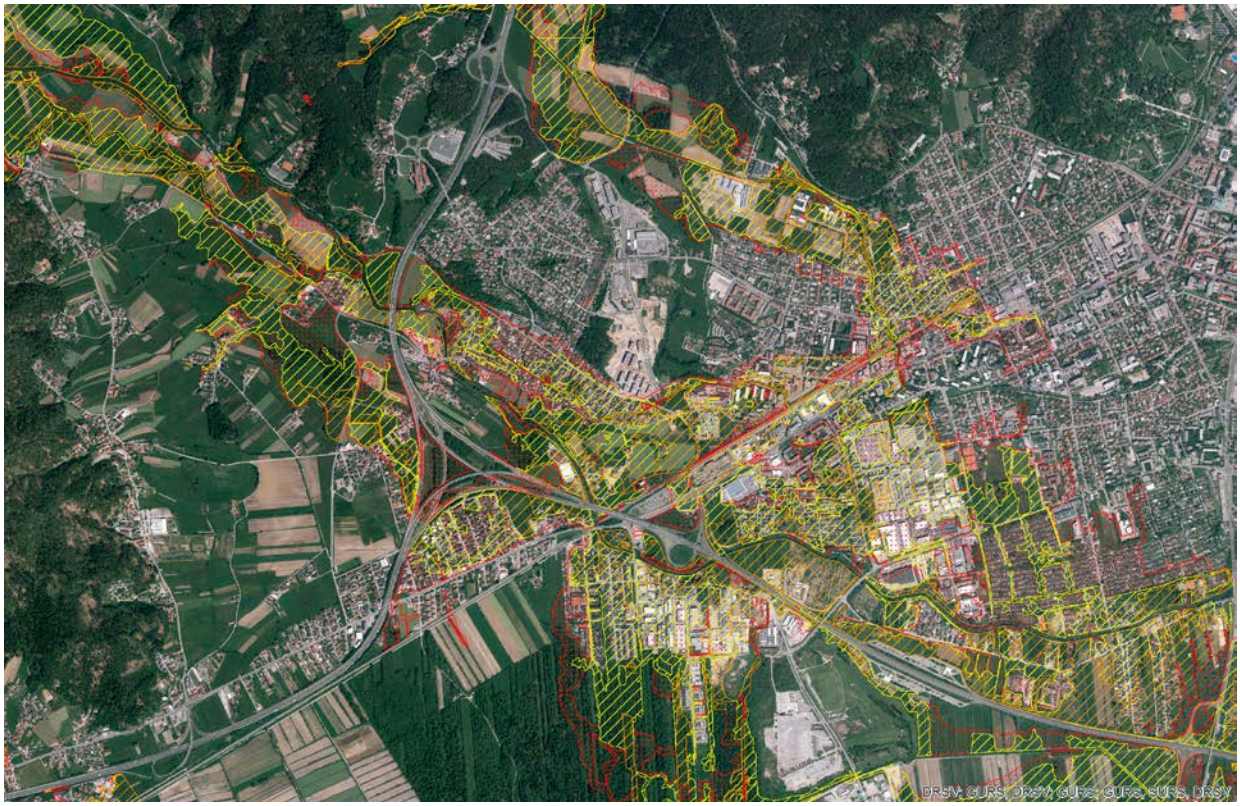

Figure 35: Publicly available flood hazard maps (Source: Atlas voda, 2018)

75. *Atlas voda, 2018.*

in such risk areas. The Waters Act defines the conditions under which landowners may intervene in the risk areas, but the detailed conditions and restrictions are defined by the government in a permit. Such a permit is issued for interventions in risk areas and must precede building permits.

The municipal spatial plans (MSP) govern spatial arrangements of local importance and define land use requirements and conditions for where objects can be placed, i.e. the so-called spatial implementation conditions (SIC) for both the entire territory of the municipality and specifically for each individual planning unit. However, those plans have not been produced yet because no regional administrative units have been formally established. At present, only the MSPs are valid for building procedures. The SICs are determined on the basis of development policy and land use and also determine, inter alia, measures to protect people and property from natural disasters. Flood, erosion and fire safety are addressed separately.[76]

Development on potential floodplains is commonly in the interest of national and social progress to some extent and has to be enabled. However, these areas need to be managed wisely and require adequate spatial planning that relies on flood hazard maps. Regulation of land use is most effective when it is directed at future development and includes residential development, commercial development and public infrastructure development. It is important that adequate non-structural measures for managing residual risk are provided. This set of measures requires careful planning and regular reviewing of plans to ensure preparedness and swift mobilization of planned actions during flood emergencies. Adequate precautions can reduce vulnerability to floods if applied prior to flooding.[77]

Governance and risk governance aspects

In the wake of the European Floods Directive, the procedures for flood hazard mapping were successfully regulated in Slovenia. The 2007-2008 flood hazard mapping legislation creates the preconditions for more effective and sustainable flood protection in Slovenia. Publicly available flood hazard maps have proven to be a useful starting point for public discussion and increased flood risk awareness. They are also useful for the participatory process, provide indispensable input in spatial planning and serve as a basic platform for integrated flood risk management. Flood hazard maps help residents and users to better understand risks. They show that even after the implementation of structural measures, hazard zones may have been reduced but never fully eliminated. Hence, a residual risk remains.

The major goals of the above-mentioned rules and decree are the establishment of clear binding terms to protect unsettled flood-prone areas with significant flood retention capacity and to ensure proper spatial planning of adequate compensation measures. Experiences from the last 10 years have shown that the evaluation and definition of an optimal set of flood protection measures (structural and non-structural) is a complex risk governance process that demands active involvement of all stakeholders on a local and state level.

On the whole, flood hazard and risk mapping in Slovenia proves to be a key aspect for a more active and effective bottom-up approach to risk reduction at a local as well as national level. Good practice examples from proactive communities encourage others to change their behaviour from not only expressing requests to the state, but instead doing as much as possible already on the local level. The knowledge about hazard and risk zones clearly raises awareness and sensitivity on the municipal level. This makes mapping an integrated and important part of risk governance processes.

DETAILS ON THE SLOVENIAN FLOOD HAZARD AND RISK MAPPING PROJECT

Institution: Slovenian Water Agency (*Direkcija Republike Slovenije za vode*)

Link: www.evode.gov.si/

76. *Mikoš et al., 2014.*
77. *Babić-Mladenović, 2015.*

4.2.3 PROGRAMME FOR FLOOD-SAFE DEVELOPMENT IN SETTLEMENT AREAS

Regulation adopted by the Styrian government

A "flood-safe" development of the settlement area poses a major challenge in spatial planning and integrated risk management. In 2005, the Styrian government adopted a development programme to minimise the risk in case of floods occurring in torrent and avalanche catchment areas by taking appropriate regional spatial planning measures. The interface between water management and spatial planning is crucial for an effective and efficient risk reduction and control. The development programme represents an essential document for integrated risk management and an important guideline for the coordination of various stakeholders.

Principles and priorities

Minimising the risk associated with flood events is a challenge that needs integrated management. The financing and planning of active preventive measures are predominantly set at the federal state level, while land-use planning itself is undertaken on a municipal level. This emphasises the need for a regional coordination between responsible institutions and other relevant stakeholders to mitigate hazards risks. The Styrian government had been discussing hazard risk mitigation for some time, when in 2002 a major flood event struck the province. The political conditions after the event sped up the discussion, and binding guidelines for spatial planning were developed. The Programme for Flood-Safe Development in Settlement Areas was subsequently adopted in 2005.

The overall aim of the programme is the consideration of hazard risk in local and regional political decision-making when it comes to developing the settlement area. Binding principles were formulated and need to be applied by planning authorities. The focus is on regional planning because only at regional level retention areas can be created and the further development of existing buildings and structures be managed. At the same time, isolated municipal decisions in land-use planning might cause long-term negative effects on overall risk development. Therefore, the key principles of the development programme are:

- keeping flood plains free of development;
- protection of existing and future settlements;
- formulation of exemptions.

Summarizing the essential statements of the development programme, risk reduction should be achieved through a variety of measures undertaken by the responsible authorities. Spatial planning thus receives a binding framework for securing flood retention areas as well as principles for developing the settlement area on a local and regional level.

Figure 36: Unfavourable municipal land-use planning, Styria (©Government of Styria)

The development programme strongly relies on binding prohibitions for municipalities in land-use planning. Basically, general principles are defined and complemented with exemptions to settlement development. The following areas must not be used as building land, as open space increasing the hazard potential and obstructing discharge, as well as for any new construction:

- flood discharge areas for floods with a 100-year recurrence interval (HQ 100);
- red hazard zones as identified in the hazard zone maps according to the provisions of the Forestry Act;
- areas which are especially suitable for flood protection measures, and blue restricted areas as identified in the hazard zone maps according to the provisions of the Forestry Act;
- riparian strips along naturally flowing water courses of at least 10 metres in width as measured from the top edge of the embankment (in some cases, if required to fulfil its function, also wider).

The development programme formulates very strict and far-reaching principles by referring to areas for 100-year flood events. Along major rivers, large and very well-suited areas for settlement development are now inaccessible for further development. Nevertheless, certain exemptions were

introduced to balance local interests and requirements. Permissions for existing buildings as well as for specified designations are still possible. Exemptions may be granted to close gap sites if they are moderate in extent. In case of a major public interest, a settlement area may be expanded, or even solitary locations may be developed.

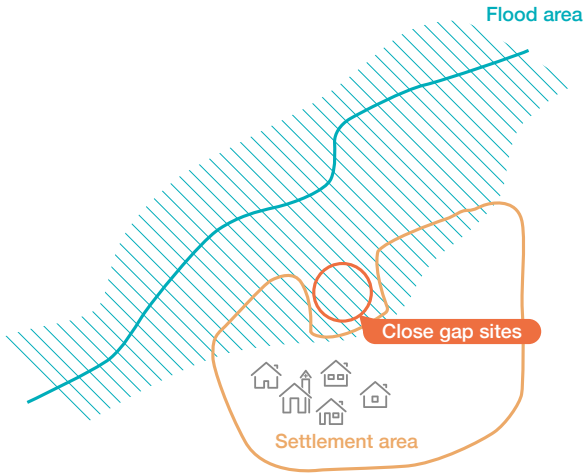

Figure 37: Example – exemptions for settlement development (©Schindelegger, 2017)

Risk governance in the programme formulation process

The development programme is a legal decree based on a traditional perception of state duties. Nevertheless, the interface between water management and spatial planning is crucial, and responsibilities are set at different levels and institutions. With the overall aim of reducing hazard risks, the formulation process of the development programme shows many aspects of a formalised governance process.

In a first stage, the Styrian government took over the role of a coordination and communication platform for involved stakeholders and at the same time the leadership in preparing the drafts for the development programme. On 14 October 2002, a resolution by the government aiming to formulate a development programme was adopted. In discussion rounds, the ideas and aims of the planned programme were examined. The basic framework for risk management, the rules for financing and certain responsibilities are defined in federal Austrian laws and could thus not be argued in the discussions. Instead, this general framework served as a basis for evaluating possible regional and local strategies in settlement development. The discussion rounds were joined by official representatives from different departments within the Styrian government, special interest groups and spatial planners. The municipalities as well as other relevant stakeholders were asked to state relevant interests. This served as a basis for the discussion. Spatial planners were specifically involved because, as consultants of the municipalities, they had a crucial role in implementing the programme.

The development programme has been effective since 2005. In 2017, an evaluation was launched. This shows that even legal decrees are only part of an ongoing discussion process and require supervision and continuous efforts.

When it comes to governance characteristics, the process itself is strongly rooted on the regional level and addresses public authorities. To consider private interests, special interest groups were included. The development programme as an essential outcome of the discussion process is single-instrumental, has a long-term strategic component and is institutionally established.

The capacities and quality of the governance process are difficult to evaluate. The process certainly shows a high degree of transparency, equity and legitimacy. The effectiveness and efficiency can be expected to be positive.

On the whole, the Programme for Flood-Safe Development in Settlement Area represents a major and unique planning instrument in Austria that picks up the idea of integrated risk management and risk governance by balancing and managing hazard risk on the level of spatial planning.

DETAILS ON THE FLOOD-SAFE DEVELOPMENT OF THE SETTLEMENT AREA PROJECT

Institution: Office of the Styrian Government, Department 13: Environment and Spatial Planning & Department 14: Water management, Resources and Sustainability (*Amt der Steiermärkischen Landesregierung, Abteilung 13 Umwelt und Raumordnung & Abteilung 14 Wasserwirtschaft, Ressourcen und Nachhaltigkeit*)

Links: www.landesentwicklung.steiermark.at/cms/beitrag/12636184/141975683/
www.raumplanung.steiermark.at
www.wasserwirtschaft.steiermark.at

SWITZERLAND

4.2.4 RESERVED OPEN SPACES FOR THE LONG-TERM REDUCTION OF RESIDUAL RISK

The following example shows how open spaces are reserved and embedded in an integrated risk management concept for the Engelberger Aa river. Reserved open spaces are strategic spatial-planning measures for the reduction of residual risk. They guarantee the long-term availability of the space necessary for the safe diversion of floodwater with minimal damage in the event of overload. This limits damage potential.

The implementation of such extensive measures requires cooperation among different disciplines and comprehensive risk governance.

Principles and priorities

Observations show that the magnitude of natural hazard events today often exceeds previously observed levels. There is no absolute safety when it comes to natural hazards, and a residual risk always remains. The impacts of climate change have also prompted the realisation that a strategy shift is needed from a purely safety-focused approach towards a comprehensive risk culture concept. Integrated risk management as practised in Switzerland is representative of this shift. In this concept, the optimum combination of planning, organisational, nature-based and structural measures is implemented with a view to managing natural hazards holistically. With the combination of these measures, unacceptable risks are reduced to an acceptable level.

Risk consists of hazard probability and damage potential. In times of growing settlements and large-scale infrastructure construction, as seen in recent decades, the damage potential posed by natural hazards increases considerably. The change with respect to hazards, on the other hand, is less pronounced, even when climate change is taken into account. The essential finding is that the risk posed by natural hazards cannot be managed through structural preventive measures alone, as acceptable risks move into the unacceptable risk range due to the continuous increase in the damage potential. For this reason, spatial-planning measures that prevent or at least reduce the increase in damage potential must be implemented along with merely hazard-focused measures.

The allocation of land uses is the central factor in reducing the increase in damage potential. For this reason, in accordance with Switzerland's legislation, flood protection

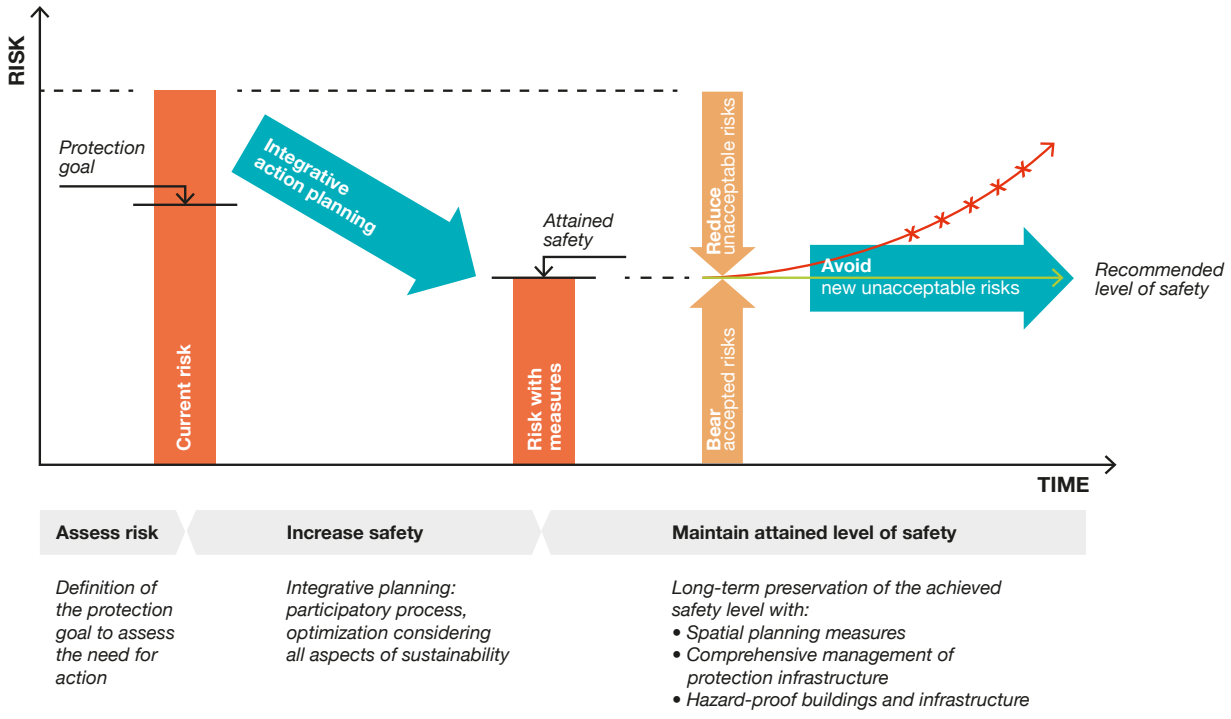

Figure 38: Risk development (Source: PLANAT, 2014, adaptation)

measures must be implemented primarily through spatial planning. The corresponding instruments include the securing of space for flood protection with watercourse zones, bans on the construction and the creation of new development zones and the designation of reserved open spaces as a strategic element. The reserved open spaces ensure the availability of the areas necessary for the safe diversion of floodwater with minimal damage in the event of overload, irrespective of intensity and return periods.

Reserved open spaces: example of the Engelberger Aa river[78]

In the period 1920-1940, the course of the Engelberger Aa river was improved to accommodate a discharge rate of 120 m^3/s, a level that corresponds to a 20-year flood. As it can be seen in Figure 39, residential settlements extended further and further from the village centres into the former flood plain.

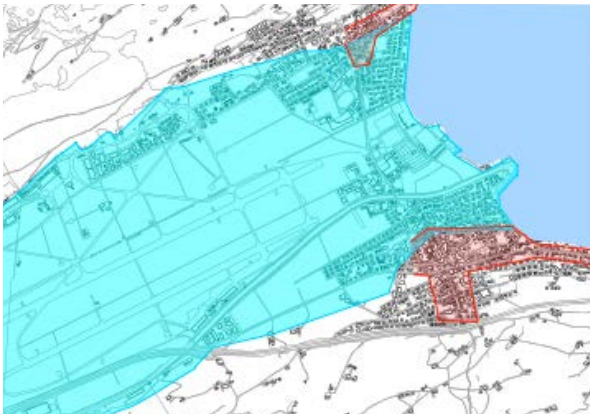

Figure 39: Potential flood plain of the Engelberger Aa before entering into Lake Lucerne with the historical villages of Buochs and Ennetbürgen (©Tiefbauamt Nidwalden, 2006)

Due to the expansion of the settlements and infrastructure, the flood risk had increased so strongly that a further improvement of the holistic flood protection concept for Engelberger Aa was necessary. This work was carried out from 1998 to 2007 in accordance with the principles of integrated risk management. The potential overloading of the flood prevention measures was taken into account in that dykes near areas with low damage potential were designed to be floodable. Thanks to the consideration of the impact on the bedload transport in the event of excess flooding, the dimensional water volume flows safely into the Engelberger Aa. Only the "excess" water flows into designated low-damage discharge corridors. The settlement area is protected against the residual risk by backup dykes.

Another important component of the holistic Engelberger

Figure 40: Situation after constructional adaptation with four floodable dyke sections, reduced residual risk area and back dykes for the protection of the settlements (©Tiefbauamt Nidwalden, 2006)

Aa flood protection project is emergency planning for damage mitigation in the event of a flood. Simultaneously with the flood protection measures, the ecology along the Engelberger Aa was improved considerably and recreational use was consistently integrated into the project.

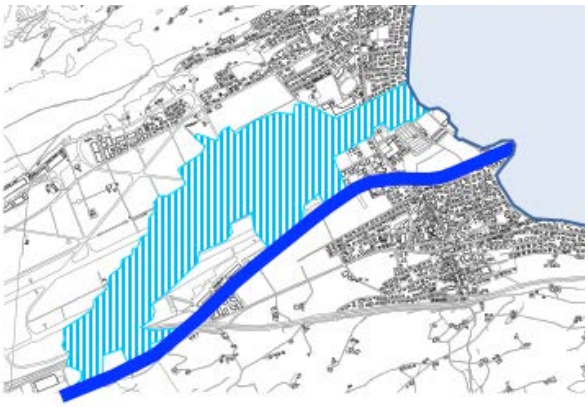

Figure 41: Reserved open spaces as defined in spatial planning. Reserved open space A (dark blue) with construction ban and other land-use restrictions. Reserved open space B (light blue) with construction permitted under special conditions (©Tiefbauamt Nidwalden, 2006)

The discharge corridors were secured on a spatial-planning basis through the designation of reserved open spaces in 2004. The inner reserved open space (A) has a construction ban as well as protection against the planting of tall agricultural crops, the erection of fences, use for parking etc. The outer reserved open space (B) is subject to less stringent regulations and can be used both for the implementation of safety measures and rezoning as a development area.

Governance and risk governance aspects

The project was commissioned by the Public Works Department of the Nidwalden canton. It was authorised by the regional parliament and the Nidwalden State Council was responsible for its environmental compliance. The decision to provide federal funding for the project was

78. Eberli, 2003. Willi, Eberli, 2006. Eberli, 2009. Kolb, 2017.

taken by the then Federal Office for Water Management (now Federal Office for the Environment). The designation of the reserved open spaces and other spatial-planning measures was approved by the inhabitants of the affected communities, who were also involved in the decisions relating to the sums provided for co-financing the project.

The fact that most of the agricultural areas were in the ownership of the land cooperatives simplified matters since they jointly manage agricultural areas.

The Engelberger Aa project was a pioneering undertaking based on integrated risk management. The project was not triggered by a damaging natural hazard event but by the acknowledgement that the potential flood risk was no longer acceptable due to settlement growth.

Both of these circumstances posed a particular challenge in facilitating the implementation of the project. The factors that led to its success were the personal commitment of those in positions of responsibility and the involvement of all stakeholders. The commitment shown by the canton's hydraulic engineer and the inspector from the supervising federal authority deserves particular mention.

To obtain the necessary authorisations, the regional parliament also had to be convinced of the need to improve the river – despite the fact that no damaging event had occurred – and of the expediency of the integrated approach. To fulfil this objective and obtain the support of the population, the process was supported by numerous public information events and a consistent press campaign over many years. Parliamentary approval was ultimately obtained without any opposing votes. This positive result was achieved in particular through the high level of commitment to the project on the part of the responsible cantonal councillor. Another key success factor was the active involvement of all of the affected authorities, such as the spatial planning and environment offices, the municipalities, associations and property owners.

DETAILS ON THE RESERVED OPEN SPACES FOR THE LONG-TERM REDUCTION OF RESIDUAL RISK PROJECT

Institution: Office for Natural Hazards, Nidwalden Canton (*Amt für Gefahrenmanagement, Kanton Nidwalden*)

Link: www.nw.ch/_docn/23984/Integrales_Risikomanagement_Engelberger_Aa_deutsch.pdf

ITALY

4.2.5 LOCAL MANAGEMENT OF GLACIAL RISKS IN THE AOSTA VALLEY REGION

A regional glacial risk monitoring plan

The Region of the Aosta Valley, situated in the far north-western part of Italy, borders with Switzerland and France in the North and West. 4% of the Aosta Valley territory is covered by glaciers. The regional glacier inventory counts 184 existing glaciers. Because of its high Alpine environment and special geomorphology, the Aosta Valley population is highly exposed to risks related to glaciers. In 2003 the government of the Autonomous Region of Aosta Valley therefore founded the *Fondazione Montagna Sicura* (FMS) organisation. The organisation deals with all aspects of risk mitigation regarding avalanche and glacial risks, from vulgarisation and communication to risk mapping and management.

Introduction on glacial risks

Glacial risks are well known in mountainous regions around the world. Different dynamics and phenomena are involved. The worst disaster related to glacial hazards ever documented happened in 1970 in Peru, where 20,000 people died in an avalanche triggered by the fall of a massive serac on Mount Huascaran. The Alps also have had major catastrophic events, such as the Tète Rousse glacial lake outburst in 1892 causing 175 fatalities and the Allalin glacier tongue destabilization in 1965 causing the death of 88 people. Glacial risk can be principally summarized in serac fall, destabilization of glacier tongues, glacial lake outbursts and rock-ice avalanches.

The Aosta Valley Region has historically been subjected to all of these types of glacial risks and is facing a continuous evolution of these risks because of the current climate.

The monitoring plan

Because many different potentially hazardous glaciers are located in the surroundings of populated areas or near major infrastructure, the Autonomous Region of Aosta Valley has devised a regional glacial risk monitoring plan together with the FMS.

The monitoring plan is primarily based on the GIS database of the glaciers of Aosta Valley. A series of potentially hazardous glaciers has been identified in a study of historical glacial hazardous events. Part of this study was carried out on the entire Alpine territory, thanks to the Glaciorisk project. The database has been completed with additional local research and is updated annually. Every year, local stakeholders such as Alpine guides and refuge owners report new glacial lakes, serac falls and other hazardous events. FMS then has the responsibility to verify the risk level of these events. At the end of every summer, technicians from the FMS glacier office perform a helicopter flight with a precise flight plan covering all of the 184 glaciers of the region. During the flight, photographs of all Aosta Valley glaciers are taken. This gives them an overview of the regional risk situation.

Every potentially hazardous glacier has a detailed folder linked to the GIS database containing historical material, updated photographs etc. Whenever any of the existing or new potential risk situations seem to require further investigation, field surveys take place and the respective phenomena can start to be monitored in precise spots. The population is encouraged to report any relevant observations.

Figure 42: Example of debris deposition on a regional road caused by the outburst of a water pocket of Rochefort glacier (©Autonomous Region of Aosta Valley)

As of now, the GIS database contains 26 potentially hazardous glaciers. On three of them, special monitoring actions have been activated (Whymper Serac/Grandes Jorasses, Planpincieux Glacier tongue, and the Brenva glacier and rock face).

Example of a critical situation managed on Grandes Jorasses in September 2014

During August 2014, the monitoring systems of the Whymper Serac on the Grandes Jorasses registered an acceleration of the unstable mass of ice towards the critical threshold of 10 cm/day of slope motion. FMS informed an expert consultant from the ETH Zurich, who confirmed the high level of risk of the situation. The geological survey

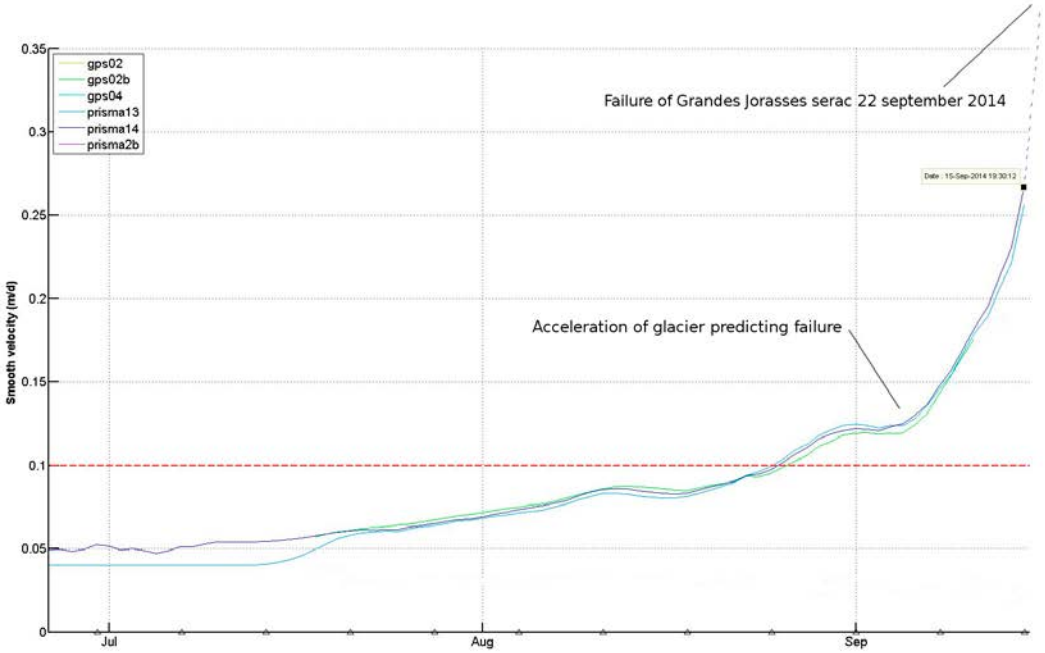

Figure 43: Velocities of the Grandes Jorasses serac in August and September 2014 (©FMS)

office of the Autonomous Region of Aosta Valley and the civil protection authority (*Protezione Civile*) where alerted. Authorities decided to prohibit the access for climbers and hikers to all trails and climbing routes on the Italian side of Grandes Jorasses on 16 September. Authorities, upon advice of experts, decided not to evacuate the village of Planpincieux. This decision was based on an existing study that included a numerical modelling of the serac fall and ice-avalanche propagation. The fall of the serac was predicted exactly 10 days in advance, to happen on 23 September. On that day, 50,000 m^3 of ice fell from the serac but neither reached the valley floor nor the village of Planpincieux, exactly as predicted by the models. A second fall of 50,000 m3 happened six days after.

Governance aspects of the monitoring plan

As shown in the example above, support for decision-makers came from the tool developed by FMS together with a safety concept by the Davos Institute for Snow and Avalanche Research (SLF). Numerical modelling of the ice-avalanche phenomenon was linked to the existing vulnerable elements and portrayed in hazard maps. Appropriate safety measures to be taken for different scenarios were defined based on different estimated volumes of ice break-off. This clearly shows the risk dimension in the decision-making process on whether to evacuate villages or close roads.

During emergency situations, the FMS works in close cooperation with the authorities of the Autonomous Region of Aosta Valley for the monitoring of the phenomena. Together, they provide data to the civil protection organisation, which arranges evacuations or citizen assistance. Public information is mainly provided by involved or affected municipalities and FMS enhances the scope of the municipality communication via its official website and its Facebook page.

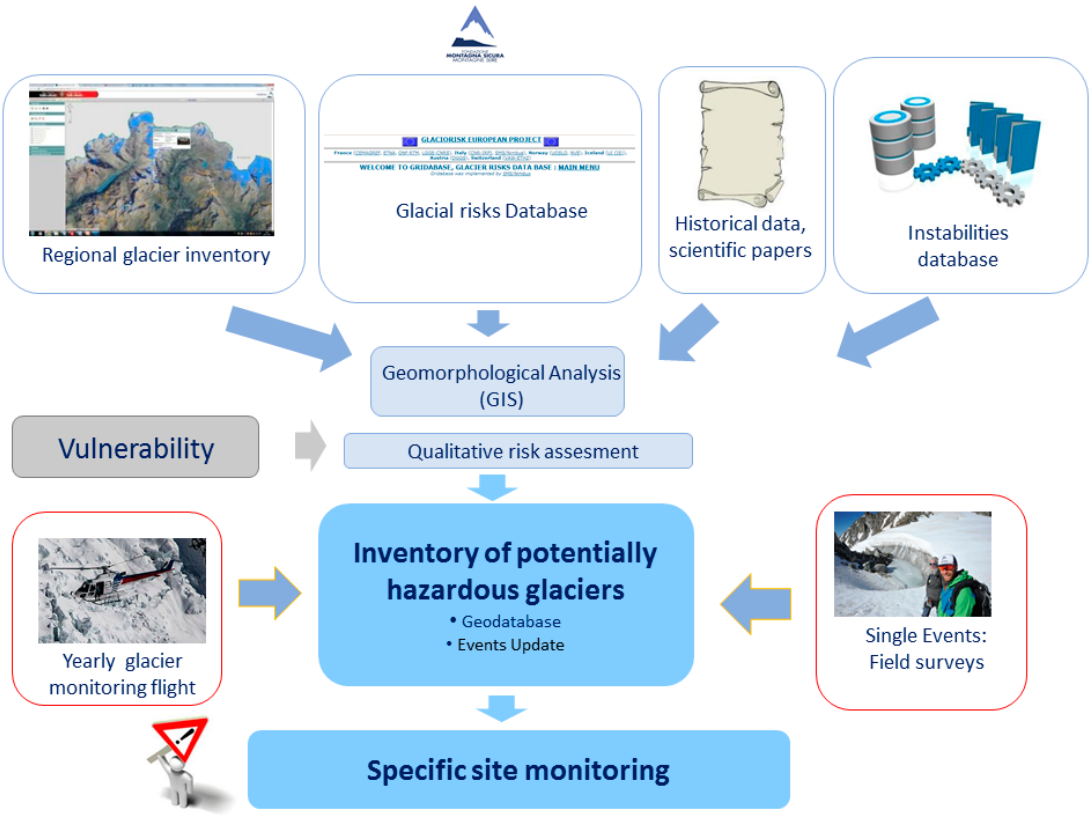

Figure 44: Scheme of the monitoring plan organisation (©FMS)

DETAILS ON THE MANAGEMENT OF GLACIAL RISKS PROJECT

Institution: Foundation "Montagna Sicura", Autonomous Region of Aosta Valley, Department for Public works, territory and public residential constructions, Office for avalanches (*Fondazione Montagna Sicura - Montagne sûre, Regione Autonoma Valle d'Aosta, Assessorato opere pubbliche, territorio e edilizia residenziale pubblica, Ufficio Valanghe*)

Link: www.fondms.org

4.3 PREPARATION AND WARNING

Natural hazard events often happen with limited forecast possibilities. Therefore, effective warning and alerting is essential. Contingency plans and other measures to coordinate rescue and relief forces help to cope with hazard situations. Switzerland has launched a project to optimise warning and alerting in the event of natural hazards. The Autonomous Region of Aosta Valley has shared the local management of avalanches via avalanche committees as a good practice example. Liechtenstein reports how local forces handle structural measures to ensure full functionality. The Province of South Tyrol provides an insight on intervention maps that help local rescue and relief forces to coordinate their actions in case of hazard events. These maps ensure that the most effective measures are carried out first and take the risk perspective into account. The following good practice examples present different approaches on how to handle preparation and warning.

SWITZERLAND

4.3.1 THE OWARNA PROJECT

Reduction of natural hazard damage through optimised warning, alerting and intervention in Switzerland

With the aim of protecting the population more effectively against natural hazards, the Swiss Federal Council initiated a project to optimise warnings and alerts in the event of natural hazards, known as the Optimisation of early warning and alerting of natural hazards project (OWARNA)[79]. OWARNA has enabled the implementation of measures for improving the quality and availability of flood forecasts, for strengthening and standardising cooperation at the federal level, for providing better information to local authorities and to the public, and for training local natural hazard advisors. The significant progress achieved by this project has led to a well-functioning warning system. Future challenges include establishing crisis-proof forecast and warning systems as well as increasing the willingness of the population to respond to warnings appropriately. To meet these challenges, the authorities and the population will essentially need to understand the potential impacts of natural hazards better.

Introduction

The flood events of 2005 caused over 3 billion Swiss francs in economic losses in Switzerland. An event analysis has shown that damage could have been reduced by approximately 20% through appropriate warning and intervention. Following the events, the Swiss government commissioned a report on how to optimise preventive protection measures, warnings and alerts for natural hazards. The Steering Committee for the Intervention on Natural Hazards (LAINAT) was established with the mission of improving the coordination between the federal authorities and establishing efficient intervention strategies.

Principles and priorities

Following the conclusions of the report commissioned by the Swiss government, a set of measures was passed with a view to improving warnings and alerts in the event of natural hazards. The aims of these measures were to:

(1) *Improve the forecast system:* this measure included the extension and updating of the existing precipitation radar network, the extension of the automatic ground measurements network, the improvement of weather and flood forecasts, and the implementation of higher-resolution thunderstorm warnings.

(2) *Intensify and standardise cooperation at the federal level:* the establishment of a natural hazards expert staff for crisis management, the publication of a joint natural hazards bulletin, common standards for warnings and for the communication of warnings to the public, and a Business Continuity Management system to guarantee 24/7 operation in case of an event.

(3) *Improve communication and information products:* the definition of common warning levels, the launch of a joint natural hazards platform (GIN) as a tool for regional and local authorities, the creation of a natural hazards web portal for public information (Figure 45), the establishment of general behavioural recommendations for the public, and the publication of joint media releases and natural hazards bulletins.

79. *Optimierung von Warnung und Alarmierung bei Naturgefahren (Optimisation of early warning and alerting of natural hazards).*

(4) *Train local natural hazard advisors:* the provision of support for local authorities in developing emergency plans and training local natural hazards advisors (Figure 46) who will support intervention forces by providing knowledge about hazard processes.

Partners and organisation

The responsibility for dealing with natural hazards in Switzerland is shared by three different administrative levels, i.e. the federal, cantonal and municipal level. The federal government's natural hazard experts warn the regional and local authorities about upcoming natural hazards and provide measured data and forecasts online. Direct information and warnings for the population are provided by federal authorities via dedicated information platforms. In case of a very high danger level (levels 4 and 5 out of 5), federal authorities have the possibility to use a "Single Official Voice" procedure, legally requiring public radio and television to broadcast the warning information. The responsibility for any intervention measures lies within the local and regional authorities.

Figure 45: Public natural hazard online platform (Source: Natural Hazards Portal, Switzerland, 2018)

The federal offices of the Swiss Confederation deal with the following threats:

- dangerous weather events: Federal Office for Meteorology and Climatology;
- floods and associated landslides and forest fires: Federal Office for the Environment;
- avalanche risk: Institute for Snow and Avalanche Research of the Federal Research Institute for Forest, Snow and Landscape;
- earthquakes: Swiss Seismological Service.

In addition, the Federal Office for the Protection of the Population supports the involved offices in the prevention of collective risks and the management of hazard events. The Federal Office of Topography (swisstopo) provides the documentation of events.

Figure 46: Training of local natural hazard advisors (©Federal Office for the Environment)

Conclusions and future challenges

Ten years after the severe flooding event in Switzerland in 2005, several measures for the optimisation of warning and cooperation have been implemented. During the flood events of 2013 and 2014, the new procedures and cooperation measures were applied successfully and helped to prevent further severe damage. Furthermore, public awareness has been considerably raised through extensive media coverage since the beginning of the events. Cooperation at a federal level is essential for effective intervention and must therefore be continued and strengthened. Future challenges that will need to be addressed in the coming years pertain to the following areas:

- *Crisis-proof forecasting and warning:* availability of forecasts, warnings and communication must be guaranteed, also in case of power shortage or infrastructure failure. Corresponding projects are currently being implemented.
- *Impact-based warnings:* the accuracy level achieved by forecast and warning products is high. However, the consequences of natural hazard events could be further reduced through impact-based warnings. These would take into account parameters such as exposure and vulnerability[80]. Studies are currently being conducted to assess the implications of this new paradigm and the possibilities it would offer.
- *Adaptation to climate change:* it is forecasted that climate change and global warming will lead to more extreme and more frequent weather-related events. Hence, there is a risk for more natural disasters. We therefore need to be prepared to face these new challenges in order to better react and reduce potential damages and casualties.

80. *WMO, 2015.*

Concerning risk governance aspects, the OWARNA project is a good example of an integrated approach that has improved forecasting and warning systems by involving different authorities as well as local people and has created a transparent institutional framework.

DETAILS ON THE OWARNA PROJECT

Institution: Steering Committee on Intervention in Natural Hazards (*Lenkungsausschuss Intervention Naturgefahren - LAINAT*)

Link: www.newsd.admin.ch/newsd/message/attachments/52033.pdf

ITALY

4.3.2 LOCAL AVALANCHE RISK MANAGEMENT ON AOSTA VALLEY ROADS

The Local Avalanche Committees

In the Aosta Valley Region 60% of the territory is at altitudes above 2,000 m. In the regional avalanches cadastre, 2,159 avalanche sites were recorded from 1970 to 2016, affecting a total area covering slightly over 17% of the region. Over the years, the construction of several avalanche shelters has greatly mitigated the hazard of avalanche events on roads and on vulnerable assets. However, they are not sufficient to totally control the danger that avalanches pose to these infrastructures. To improve avalanche risk management further, the Autonomous Region of Aosta Valley introduced a system of Local Avalanche Committees (CLV) in 2010.

Principles and priorities

In the last 35-40 years, snow bridges and snow nets have been built in 172 sites together with numerous passive structures, such as deflecting or restraining dams and 36 tunnels were built to prevent closures caused by avalanches on the national and regional roads (Figure 47). The region is still far from having a complete *structural* protection – which is actually unachievable for technical and economic reasons – but additional *non-structural* measures can be applied to improve protection.

Road closures, evacuations, artificial triggering of avalanches, snow modelling of the deposition area and remote-event controlled traffic lights are some examples. They are, however, very difficult to manage on a large scale by the regional avalanche warning service. Therefore, local management is needed in order to increase the effectiveness of the measures. Furthermore, interaction between local management and a regional forecast can make forecasting more effective and timely, allowing the optimisation of risk management.

Figure 47: Example of deposition area that blocks the tunnel entrance (©Autonomous Region of Aosta Valley)

Regional law

Several villages in the Aosta Valley Region are located in remote valleys only accessible by a single road. In the past, it was quite usual for inhabitants to remain isolated for several days because of intense snowfalls and avalanche danger. Nowadays, most of these villages have high numbers of tourists and the residents need to be able to commute to work or school. The last large-scale critical situation for such villages happened during the 2008-2009 winter season, when almost 200 spontaneous avalanches were registered from 14 to 17 December. They also reached the valley floors,

affecting roads and infrastructure, disrupting power and communication lines, and isolating entire villages. To better manage such critical situations in the future, the Regional Council of Aosta Valley passed a regional law in 2010 to establish CLV and to regulate their powers and functions. The council further defined the CLV's operating method including the support of the regional avalanche warning service, the municipalities and the operators of the local ski resorts. It also regulates how to forecast and to evaluate weather conditions and the stability of the snowpack. Furthermore, it defines how to manage surveillance, early warning and possible intervention in risk and emergency situations, and how to ensure local control of dangerous situations in the territory of competence based on uniform criteria and methodologies.

Seventeen CLVs have been set up for the municipalities with a high avalanche risk. Each CLV is composed of: one to three mountain-guides, the operational managers of the ski resorts within the area of relevance and the commander of the forest ranger unit having jurisdiction. All of them attended courses on the topics of snow and avalanches, on the regional avalanche warning service and according to the professional education guidelines of the Association of Snow and Avalanche Warning Services (AINEVA).

The CLVs are advisory bodies which support the Autonomous Region of Aosta Valley, the municipalities and the operators of the ski resorts and aim to ensure the local control of dangerous situations within their territory of competence.

Essential activities established by law to be carried out by the CLVs are:

- preparing the Avalanche management activity plan (PAV);
- obtaining data and information related to the avalanche danger and its likely development;
- providing, on request, technical advice about the avalanche danger in the territory of competence and its likely development;
- supporting the activities of the mayors for the adoption of any measures and initiatives to be taken in relation to a critical state;
- cooperating in emergency management with the municipal and joint operation centres as well as with the coordination of relief efforts.

Example of the critical situation managed by CLV between 1 March and 16 March 2014:

On 1 March 2014, a snowfall of 50-80 centimetres was registered at an altitude of 2,000 m in the Gressoney valley and Val d'Ayas. These snowfalls, associated with moderate winds, formed new drifts at altitudes above 2,000 m, further overloading the slopes. The regional snow and avalanche bulletin for 1 and 2 March quoted a high danger level of 4 for the Gressoney, Ayas and Champorcher valleys and for

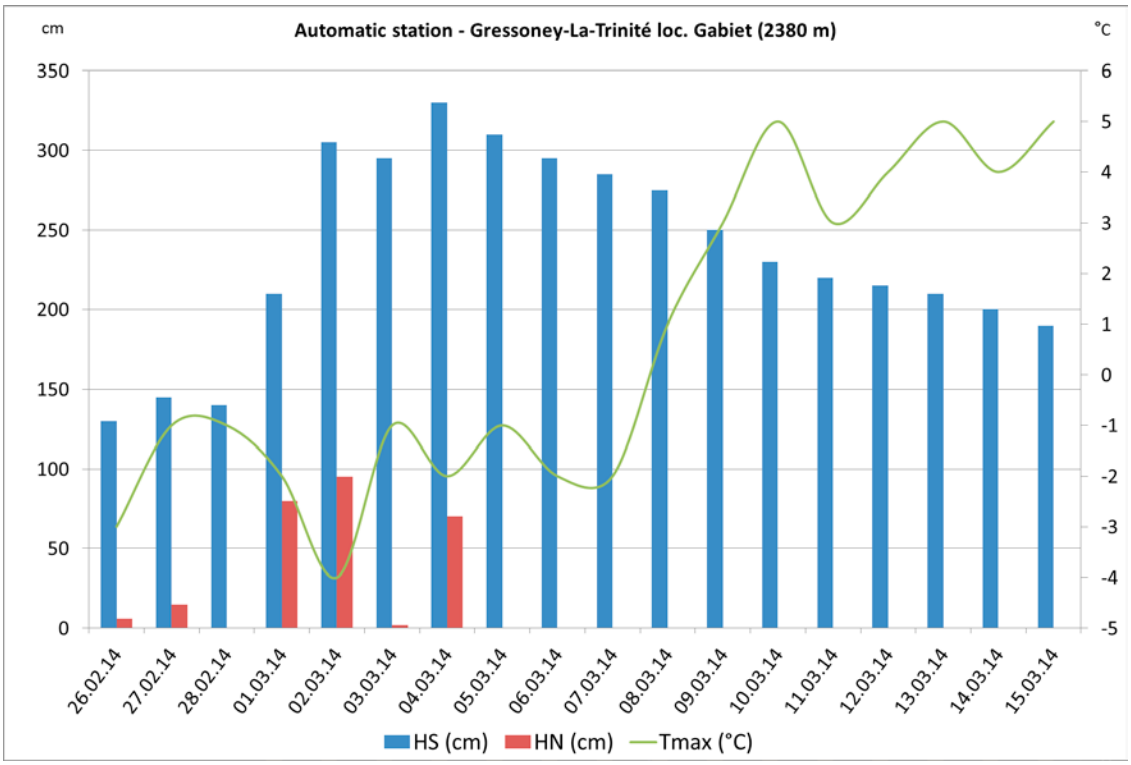

Figure 48: Snow level data (HS: ground snow; HN: fresh snow- in cm) and maximum temperatures (Tmax, in °C) from 26 February to 15 March 2014 in Gressoney Valley (©Autonomous Region of Aosta Valley)

the high parts of Valtournenche. On 1 March, the regional Gressoney valley road was closed, and on 2 March three avalanches went off.

During the night of 3 to 4 March, 70 cm of additional fresh snow fell in these valley. On 4 March, at the end of the bad-weather period and for the first time during the winter, the temperature began to rise progressively and steadily. This continued throughout the following days. In particular, the maximum temperatures at 2,300 m from 8 to 16 March exceeded the +5°C mark (see Figure 48).

As a consequence of the rising temperature, there were numerous avalanches, some reaching the bottom of the valleys.

The closure of the Gressoney valley regional road in conjunction with the heavy snowfalls on 1 and 2 March turned out to be an adequate and timely precautionary measure. The hazard in this case, proved by the events, was high, and the economic loss was relatively limited. However, the risk connected to the increase in temperature was underestimated. The CLV should have closed the road from 8 March until the most important events had taken place, given that the temperature did not fall again until 16 March. In retrospect, one could have reasonably considered a closure of at least three days (Saturday 8, Sunday 9, and Monday 10), but in this case, the economic loss would have been high.

Local evaluation allows optimising the road closing times and thus reducing the disadvantages for the population as well as economic losses. This requires thorough knowledge of the territory and an ever-greater interaction with the regional administration to handle the forecasting.

Governance aspects of local avalanche risk management

The CLVs have several advantages for local avalanche risk management. They can provide:

- adequate monitoring in several areas of the region;
- prompt action before and after the events;
- enhance local knowledge based on past events.

To effectively manage CLV activities during forecasting, in times of avalanche danger and when an actual event occurs, a homogeneous instrument for the acquisition, visualization and storage of data, the operating transparency, the definition of responsibilities and the traceability of the operations conducted is necessary. Such a tool was developed within the Start-It-Up Alpine Space project.

The newly established CLVs strongly rely on local knowledge of the people living and working in relevant areas. The Regions' role is mainly to provide data and tools, as well as the hazard assessment on a regional scale, but the decision-making process of hazard management and of its related risk happen within the CLVs. This local focus helps to be flexible for site visits and integrates information provided by locals. The CLV system can therefore be considered a successful avalanche risk management practice with a clear risk governance approach.

DETAILS ON THE LOCAL AVALANCHE RISK MANAGEMENT ON AOSTA VALLEY ROADS PROJECT

Institution: Foundation "Montagna Sicura", Autonomous Region of Aosta Valley, Department for Public works, territory and public residential constructions, Office for avalanches (*Fondazione Montagna Sicura - Montagne sûre, Regione Autonoma Valle d'Aosta, Assessorato opere pubbliche, territorio e edilizia residenziale pubblica, Ufficio Valanghe*)

Link: piattaformaclv.regione.vda.it/

LIECHTENSTEIN

4.3.3 CONTINGENCY PLANS FOR TORRENTS

Know-how transfer and capacity building with local forces

In Liechtenstein, preventive measures against natural hazards use probabilities as a basis for calculations as well as decision-making. However, events can be bigger than the profile of a torrent or the dimension of a structural measure was designed for. Contingency plans are an appropriate instrument to transfer the knowledge of those limitations to the local forces. Accordingly, the existence of a contingency plan describing each torrent as well as the function, handling and limitation of each technical structure is eminent. To fulfil this target, the developed contingency plan system describes the functions of the torrents and their structures depending on the size of the event. To guarantee an effective use by the local forces, an easy, understandable and applicable plan is compulsory. The Liechtenstein contingency plan programme also includes instructions for application as well as the establishment of special local water brigades.

Principles and priorities

There are three main aspects to be analysed as a basis for contingency plans: first, the knowledge about the possible effect of an extraordinary event is crucial. Therefore, all contingency plans must be based on accurate hazard maps of the relevant processes, which not only show event sizes up to a 100-year event, but also extreme events (1,000-year event). Second, the function, limitation and handling of each structure have to be known and described, especially for the case of an overload. Once these aspects are in place, the third aspect comes into play: this is the circulation of the content of the contingency plans to the responsible people in the local communities.

As past events have shown, the lack of knowledge is not only caused by missing contingency plans, but also by the missing awareness of those plans. To guarantee stable knowledge, each municipality established a water brigade that takes the lead in all events caused by torrents or landslides. The brigade is usually headed by the local forester, whose daily work assures the necessary know-how about the catchment area and the existing structures in the torrents. Additionally, each municipality is divided into different sections, each with its own person in charge.

Key factor: capacity building

The water brigade programme was established after the 2005 event, when various damages occurred. An analysis showed that a lack of the missing know-how about the function and handling of the preventive structures was responsible for the inadequate hazard response. It also revealed that the training of the fire brigades alone could not guarantee sustainable expertise since their operational rules do not provide for permanently available specialists. After the water brigades were established, their specialized training started on the basis of the hazard maps. The contingency plans were implemented with their detailed description of each major structure. All this was to fulfil the aim of minimizing damages caused by potential inadequate or ineffective actions.

The contingency programme is led by the Office for Civil Protection. In cooperation with the local forester and the fire brigades, it was easy to convince the local authorities of this necessary shift in torrent management. Once introduced, the system can only be sustained if the local responsible persons are willing to keep the contingency plans updated and have regular trainings.

The example in Figure 49 and Table 2 shows the necessary measures depending on the actual phase and condition of each element of the structure. The scenarios are specified during the hazard mapping process. The functions and limits of particular elements are known from existing structures. So, the main task is to bring all this information together into an easily readable paper that can be easily used during an event also by non-professionals.

Governance and risk governance aspects

The programme's goal was to reduce damages caused by big events or by unforeseen processes through contingency plans. Governance was not an issue initially. However, an effective contingency programme requires an active and ongoing collaboration between actors on the national and local level. Different stakeholders at different levels, from the federal state to the municipal level, as well as certain local actors need to be involved in the process. Although there is a legal basis that defines federal and local responsibilities in case of an event, the newly established water brigade system is rather informal. Knowledge transfer and capacity building ensure coherence for all involved levels and actors.

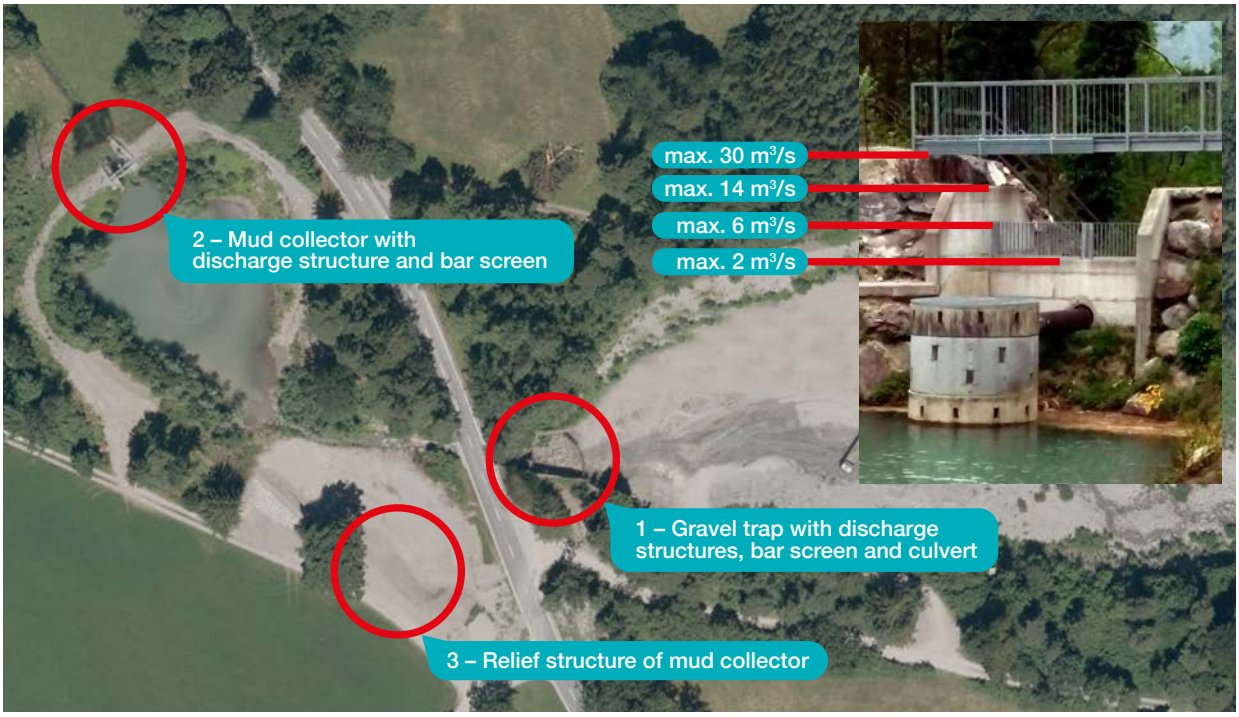

Figure 49: Detailed overview of the different technical structures in a torrent (©Office for Civil Protection, Liechtenstein)

Scenario	System Element	Condition	Measure	Phase
Frequent event (HQ 30)	1	✓ ok (bed load deposition) ? danger of clogging	• Gravel trap: none • Monitoring bar screen, spillway and culvert; organizing log grapple	**YELLOW**
	2	!! clogging	• Cleaning screen with log grapple	
	3	✓ ok	• None	
Average event (HQ 100)	1	✓ ok (bed load deposition) !! clogging	• Gravel trap: none • Cleaning bar screen, spillway and culvert with log grapple	**ORANGE**
	2	!! clogging	• Cleaning screen with log grapple	
	3	? danger of clogging	• Monitoring of relief structure: removing logs	
Rare event (HQ 300)	1	✓ ok (bed load deposition) !! clogging	• Gravel trap: none • Cleaning bar screen, spillway and culvert with log grapple	**RED**
	2	!! clogging / overloaded	• Cleaning bar screen with log grapple	
	3	? danger of clogging	• Monitoring of relief structure: removing logs	
Extreme event	1-3 all	Analogue to HQ 300 water 25 m³/s, bed load?	• Analogue to HQ 300	

Table 2: Detailed measures for each structure or element for different phases during an event – simplified (©Office for Civil Protection, Liechtenstein)

DETAILS ON THE CONTINGENCY PLANS FOR TORRENTS PROJECT

Institution: Office for Civil Protection, Liechtenstein (*Amt für Bevölkerungsschutz, Liechtenstein*)

Link: www.abs.llv.li

ITALY

4.3.4 INTERVENTION MAPS

Intervention planning plays a crucial role in integrated natural hazard and risk management.

The Civil Protection Agency of the Autonomous Province of Bolzano/Bozen in South Tyrol, Italy, has created a new instrument to improve emergency preparedness together with the voluntary fire brigades: the *intervention map*. This tool helps the fire brigades to manage the first emergency phase in the immediate aftermath of debris flow or avalanche events.

Motivation

The Alpine area, located in the heart of Europe, is constantly affected by natural hazard events such as floods, landslides or avalanches. Integrated natural risk management goes beyond mere structural measures to protect settlements and infrastructure. It uses spatial planning instruments, initiatives to raise awareness among the affected population and training of task forces to deploy preventive emergency measures. To support preventive emergency planning, an intervention map for water-related hazards and avalanches was developed for the local fire brigades in South Tyrol.

The objectives of intervention maps are to:

- reduce damage to people, goods, the environment and economic activity caused by natural hazards;
- optimise personnel and resource allocation;
- ensure information transfer during the emergency phase;
- support rational decision-making and appropriate situational response;
- improve the safety of the deployment forces.

By analysing the risk and defining potential response measures, the intervention map helps decision-makers to gain extra time and knowledge.[81]

Structure of intervention maps [82]

The intervention map is a simple support instrument for the effective management of the operational organisations. It is composed of two interconnected parts: a cartographic and a text component with a basic risk analysis.

The cartographic component consists of general information

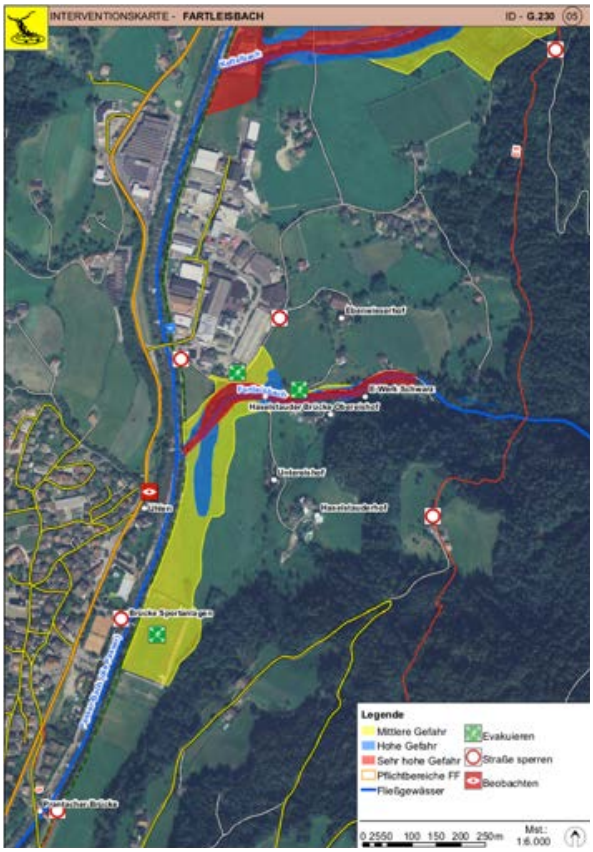

Figure 50: Example of an intervention map (Author: Martin Eschgfäller)

about the location, the name of the watercourse or avalanche, information about hazard-prone zones and symbols showing initial measures on an aerial photograph. Event documentation, hazard maps or hazard studies provide realistic and scientifically based data about the development, and the dynamics of hazard processes.

The textual component on the back of the map consists of a list of the hazards classified into hazard categories. This is followed by a section on decision-making procedures and initial measures that need to be implemented in case of an event. The decision-making rules and measures take into account the knowledge of the volunteers in the fire brigades and are ranked according to priority. The final part of the textual component is a list of the bodies and persons to be contacted during an event.

To generate an intervention map, a specific hazard zone is selected. Then, a trained personnel (external consultant) accompanies the local fire brigades in the preparation

81. *Gallmetzer et al., 2016.*
82. *Eschgfäller, 2012.*

of the maps. The content of the maps is compiled in cooperation with the local fire brigades. The experience and knowledge of the personnel involved in past events, the local knowledge and the knowledge about the available resources are incorporated into the work. The external consultant provides the fire brigades with the cartographic and textual bases, organises the process and compiles the final products. The intervention map is therefore a product developed at the local level. This increases the quality and the acceptance of the product. At the same time, this instrument also serves for training purposes.

Governance and risk governance aspects

Intervention maps represent valuable planning tools for fire brigades to effectively deal with field operations in the first emergency phase in the immediate aftermath of occurring debris flow or avalanche events. It also optimises complex interventions in settlement areas with high risk potential. This planning instrument complements the existing planning tools for natural hazard risk management. Using such tools helps to improve the safety of the task forces, to optimise personnel and resource allocation, to enhance the flow of information and to support rational decision-making, and the associated situational response in order to reduce damage to people, animals, goods and the environment.

Intervention maps are based on an informal cooperation with a local voluntary organisation in which the public authority provides expertise and a certain framework. The actual responsibility for organising training and keeping information up to date is at the local level. Intervention maps clearly have a strong risk governance aspect, focusing on risk reduction by improving the local response and involving the voluntary fire brigades.

Figure 51: Rescue unit training (©Autonomous Province of Bolzano/Bozen, Civil Protection Agency)

DETAILS ON THE INTERVENTION MAPS PROJECT

Institution: Autonomous Province of Bolzano/Bozen Civil Protection Agency (*Südtiroler Landesverwaltung, Agentur für Bevölkerungsschutz / Amministrazione Provinciale di Bolzano/Bozen, Agenzia per la Protezione civile*)

Link: afbs.provinz.bz.it/

4.4 BUILDING BACK BETTER

After hazardous events, public authorities are required to support municipalities and affected people not only with subsidies and reparations to rebuild damaged areas but also to *implement measures to prevent future events*. A profound analysis of the event helps to understand hazard processes and demarcate hazard areas. Risk calculations can be undertaken and serve as basis for rebuilding affected areas in a less vulnerable manner.

SLOVENIA

4.4.1 MITIGATION OF LARGE LANDSLIDES AND DEBRIS FLOWS IN SLOVENIA

Example of Stovže landslide and Predelica torrent debris flow

In the last decades, the Slovenian National Assembly adopted a series of legal acts that provide the (financial) resources for the mitigation of large landslides and debris flow events. The main incentive for the new legislation was the damages caused by the Stovže landslide in the municipality of Bovec and other large-scale landslides in autumn 2000. Following the relief and repair measures, detailed regulations for zoning and real estate development in the affected area of Log pod Mangartom were adopted. Buildings were constructed to allow the evacuated inhabitants to return. This special case is an example of a successful reaction to a large-scale catastrophe in a multi-sector and multi-disciplinary approach. It involved many actors as well as formal and informal solutions in the four phases of risk management - response, recovery, preparedness and prevention.

Principles and priorities

To mitigate the impact of large landslides, the Slovenian National Assembly adopted a law for landslides triggered by heavy rainfalls. According to the Public Finance Act and the Financing of Municipalities Act, financial resources for disaster mitigation are provided jointly by the state and the municipalities. 1.5% of the general annual budget is dedicated as a reserve for occurring disasters. In case of an event, the first step is an estimation of the direct damage conducted by the Ministry of Defence. For the state financial funds to be activated, the estimation of the mitigation costs for all landslides triggered within a period of 90 days must be at least 0.3% of the annual budget of the Republic of Slovenia. Implementation of the reconstruction is coordinated by the Natural Disaster Reduction Division in the Ministry of the Environment and Spatial Planning. The ministry provides beneficiaries/victims counselling and assistance in planning, designing, and financial and construction supervision in the reconstruction. The municipalities are in charge of the reconstruction of public infrastructure facilities of local importance.

Geohazards in Slovenia

The territory of Slovenia is characterised by high geological and tectonic complexity. The principal geologic feature of Slovenia is its very diverse lithology, which is mainly composed of sediments or sedimentary rock. Approximately one third of the land and 20% of its inhabitants are highly exposed to mass movements due to morphological, geological and tectonic conditions. In general terms, slope movements occur in almost all parts of the country. In recent years, intense rainfall events caused numerous shallow landslides, which represent one of the predominant types of mass movements in Slovenia. Although landslides are a local phenomenon, the 15-year average landslide damage represents 7.6% of total damages due to disasters in Slovenia. In the past 15 years, over 10 people were killed in landslide events.[83]

For this reason, effective risk reduction strategies in risk management for landslides and debris flows are crucial in Slovenia. Effective protection against landslides means developing settlements outside hazard-prone areas. This can only be achieved by the joint efforts of experts and responsible authorities. Nevertheless, prevention through risk and hazard-sensitive land-use planning is an appropriate and effective prevention strategy. As a general basis for such decisions, geohazards are assessed and depicted in maps. One such map is the landslide susceptibility map and another one the debris-flow susceptibility map of Slovenia, both on the scale of 1:250,000.

Despite the developed methodologies, geohazard assessment is still rarely used in spatial planning on the local level, mainly due to the lack of adequate landslide protection legislation. The relevant legal act is the 2002 Water Act that foresees several legislation documents to be accepted by

83. *Eschgfäller, 2012.*

the ministry in charge for water management in Slovenia. Thanks to the European Floods Directive, procedures have already been regulated in the field of flood management but still have to be regulated in the field of other water-related natural hazards and geohazards, such as landslides, rockfalls and debris flows. In all recent national regulations, prevention is prioritized over intervention during natural disasters. However, how to act during and after hazardous events is more precisely defined than how to prevent them.

Disaster management of Stovže landslide and Predelica torrent debris flow in 2000

On 17 November 2000, the village of Log pod Mangartom, Bovec municipality, was hit by a debris flow of the magnitude of 1.2 million m^3. The Stovže landslide, which reached the valley in the form of debris flow, destroyed the torrential beds of Mangartski potok and Predelica as well as a part of the Log pod Mangartom village. Seven people lost their lives during the event. The inhabitants of the village were evacuated. In total, six houses and seven farm buildings were destroyed. Eleven houses and one farm building were damaged. Two bridges on the state road to Italy were destroyed. Two small hydropower plants were damaged. The total damage amounted to 36 million euros.

Warnings by the Administration for Civil Protection and Disaster Relief were passed to the competent authorities, the rescue services and the public. The local disaster management system was activated. The whole village was evacuated to Bovec, two ad-hoc teams of experts were formed and a 24-hour observation of the landslide area together with a special mobile public alerting system were put in place. The Civil Protection Headquarters adopted emergency measures: (i) observation of the entire area affected by the landslide and the debris flow; (ii) immediate landslide consolidation measures; (iii) urgent torrent control measures; (iv) reestablishment of the road connections; (v) assurance of the basic living conditions and economy in the affected area; (vi) necessary corrections in spatial planning. The local fire brigade units were activated: (i) rescue, transportation and supply for affected people; (ii) observation of the torrents and landslide; (iii) care for the property and animals left in the village; (iv) informing the evacuated inhabitants about the situation in the village.

The intervention of civil protection units during the event and in the following days and weeks was immediately followed by the reconstruction of the devastated area. The area of Log pod Mangartom, though, remained threatened

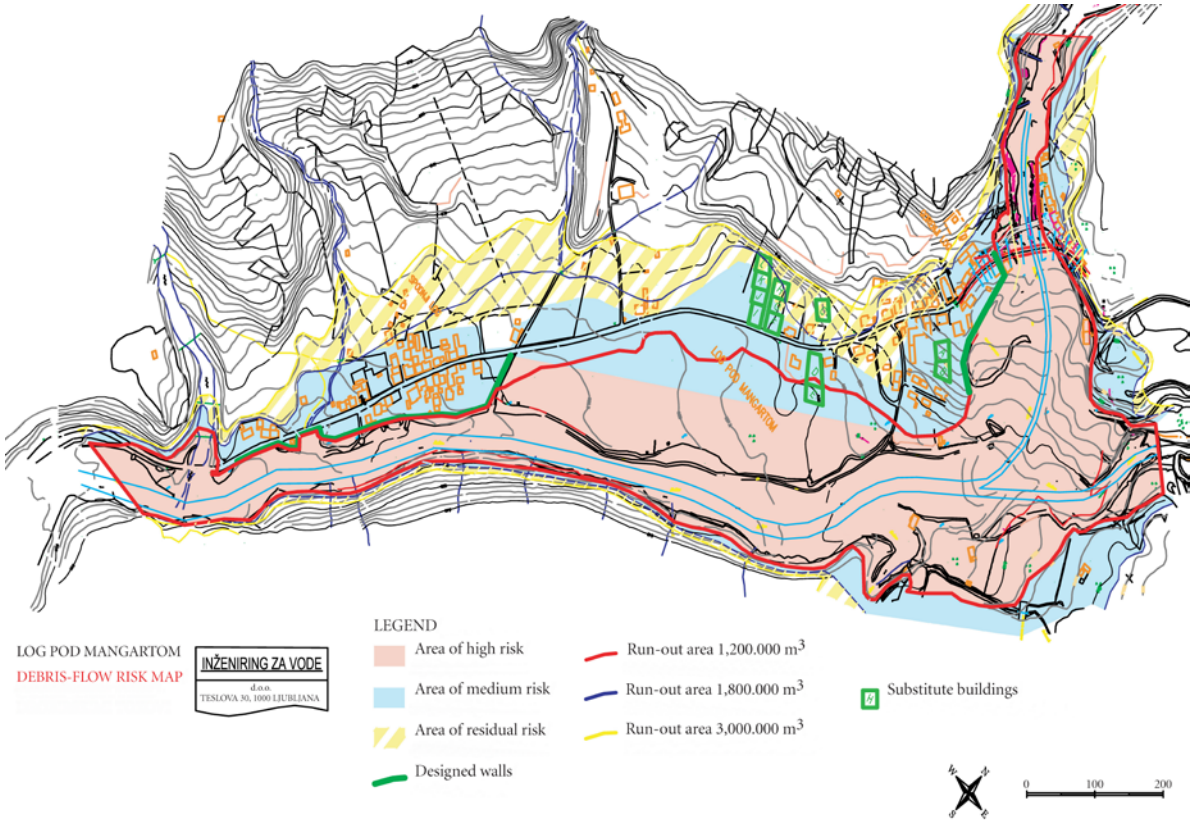

Figure 52: Debris-flow risk map with location of new buildings (Source: IZV, 2004)

by possible new debris flows from the Stovže slope above the Mangart mountain pasture. Therefore, limitations for the reconstruction in the debris-flow risk area of the village were necessary. A special decree was issued by the Slovenian government. This regulation was the first of its kind in the field of spatial planning in Slovenia and has been serving as a valuable basis for successful risk mitigation. An expert group prepared a debris flow hazard and risk map (Figure 52) of Log pod Mangartom with run-out areas of debris flows shown and a classification into three risk areas (high, medium, low/residual). The third category was the basis for the location of new buildings during reconstruction. At the moment, 15 new buildings have been built and all inhabitants of Log pod Mangartom have moved back to the village.

Governance and risk governance aspects

The experiences gathered during the Stovže landslide event and the Predelica torrent debris flow, as well as the following legal regulations, served as starting point for handling other large landslide disasters in the last few years and have had an important influence on today's approach on how to mitigate landslides. Despite the existing regulatory framework, there are no standard solutions. Problems need to be addressed and solved case by case. Concerning risk governance, the Slovenian way of handling landslide and debris flow events shows how important the inclusion of all phases in risk management are, and what role risk could have. Many different stakeholders (authorities, NGOs, the general public) were involved in actual rescue and relief actions, the recovery phase, and the decision on future prevention strategies, in particular regarding planning issues. The described event was a trigger for extensive discussions that resulted in the formulation and adoption of comprehensive regulations, legal acts, and better coordination between municipalities and the state administration.

DETAILS ON THE MITIGATION OF LARGE LANDSLIDES AND DEBRIS FLOWS IN SLOVENIA PROJECT

Institution: Ministry for Environment and Spatial Planning, Natural Disaster Reduction Division (*Ministrstvo za okolje in prostor, Sektor za zmanjševanje posledic naravnih nesreč*)

Link: www.mop.gov.si/si/delovna_podrocja/zmanjsevanje_posledic_naravnih_nesrec/

5. CONCLUSIONS

Promoting and implementing the risk governance concept for natural hazards signifies a *shift from hazard protection, hazard management and risk management to an inclusive, stakeholder-based system* with a broader and more in-depth view. Such a shift cannot be performed suddenly. Instead, it is a slow transition process.

Implementing risk governance mechanisms means *involving concerned or affected people and other stakeholders* on different spatial, sectoral and administrative levels. Therefore, it is imperative that the setting has to be open to the result of the process. Risk governance cannot always provide better solutions for hazard prevention in less time. What it can do, however, is to ensure that the solutions found are widely supported. In a risk governance process, frameworks for decision-making are partially defined by the participating actors. This develops the risk management approach further and tends to be more effective than a predominantly state-led hazard and risk management system.

Governance processes are complex. They require human resources and financing, and the final result is difficult to predict. Therefore, the governance concept challenges public authorities. *The legal and regulatory frameworks need to be adaptive* to a more open and uncertain discussion among peers.

The big advantage of fostering risk governance is the *sharing of responsibilities.* Affected people and authorities negotiate actions, clarify and share responsibilities, and it is no longer an exclusively government-based task to take care of a risk-based development. This means that affected people initiate action by themselves and take on responsibility. Such multi-instrumental and multi-institutional approaches can foster innovative low-regret strategies that increase safety, lower vulnerabilities and have positive ecological effects. They can also help stakeholders to understand that sometimes a structural protection measure might be the best option while in another case it might be better to opt for a nature-based solution and include spatial planning or organisational aspects. There is no "one fits all" solution. Therefore, the discourse is important.

There are also challenges in implementing governance mechanisms. For example, it is necessary to avoid discussions without results or having strong actors that just call for one simplistic solution that is publicly financed. Risk governance means sharing responsibilities and creating sustainable solutions combining different measures. Such a process needs time and demands *flexibility of all involved actors.*

The good practice examples for risk governance in the Alps illustrate the wide range of potential applications. Structural protection measures are by far not the only solution for risk management. The numerous efforts to involve people from various sectors and administrative levels show that risk governance in the Alpine Convention perimeter is underway. With a long tradition in hazard prevention, the Alps can be considered a living lab for risk governance, also from a global perspective. The Alps are a living and working environment as well as a recreation area and an ecological treasure. At the same time, they are highly exposed to natural hazards and to development pressures. Innovative solutions are developed here in real life, and the *Alps represent a paramount example of risk governance in mountain regions.* Platforms and exchange on local up to international level among researchers, practitioners and decision makers are absolutely needed to enhance risk governance.

Based on the evaluation of the status quo of risk governance in natural hazard prevention in the Alps, this report provides the following conclusions and recommendations:

Conclusions

- Risk governance needs targeted risk communication. An active dialogue between public stakeholders (policy makers, experts in administration) and civil society is fundamental for effective governance processes. Making useful information available and understandable raises risk awareness and establishes a risk culture in society.

- Successful risk governance processes need a framework with a clear goal as well as carefully selected public and private participants – in terms of sharing a common risk. The hazard and risk situation needs to be identified and evaluated by public authorities first.

- Risk governance cannot easily be compared within and between countries because processes differ widely in their characteristics, qualities and capacities.

- Risk as well as governance are complex concepts that further increase the complexity of natural hazards management. A common understanding and an active exchange among involved experts and other actors is necessary for effective results.

- Fostering risk governance means to challenge existing legal and regulatory frameworks. They need to be adaptive and allow the involvement of affected people and stakeholders in natural hazard prevention and to share responsibilities.

- Risk governance processes can help to establish a broader view and mutually develop a combination of measures for an integrated solution for a certain hazard situation.

Recommendations

- *Promote risk governance as a concept* to enhance hazard and risk management. Communicate the opportunities and challenges of establishing risk for preventive policies and governance for prevention and preparation activities.

- *Use risk governance to develop effective protection and management systems*. The combination of measures, the cooperation of stakeholders and sharing responsibilities with affected people and institutions raise the complexity of natural hazard and risk management. However, they foster innovative bottom-up solutions that can be highly effective.

- *Integrate local initiatives* in developing solutions. Risk governance is an inclusive approach. Initiatives can be started by any concerned party, and public authorities need to be able to work with all stakeholders at eye level.

- *Provide (financial) incentives* to promote participatory approaches in the various development steps of protection and prevention systems.

- *Base risk governance on expertise.* Professional risk governance needs to develop expertise among stakeholders and affected people. Only then can they successfully participate as informed stakeholders in such processes.

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ANNEX I
NATURAL HAZARD EVENTS IN THE ITALIAN ALPINE CONVENTION AREA

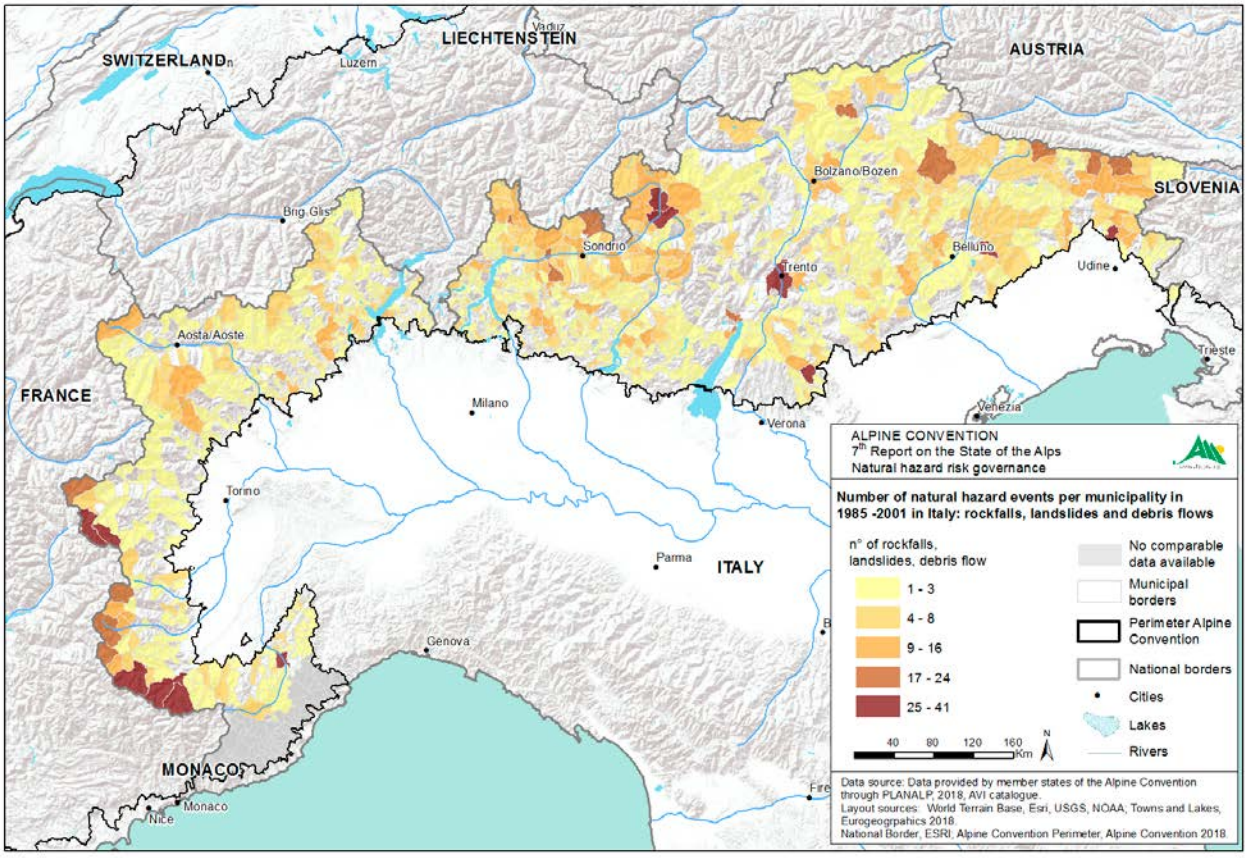

Figure 53: Landslides, rockfalls and debris flows in the Italian Alps in the period 1985-2001 (Source: AVI Catalogue)

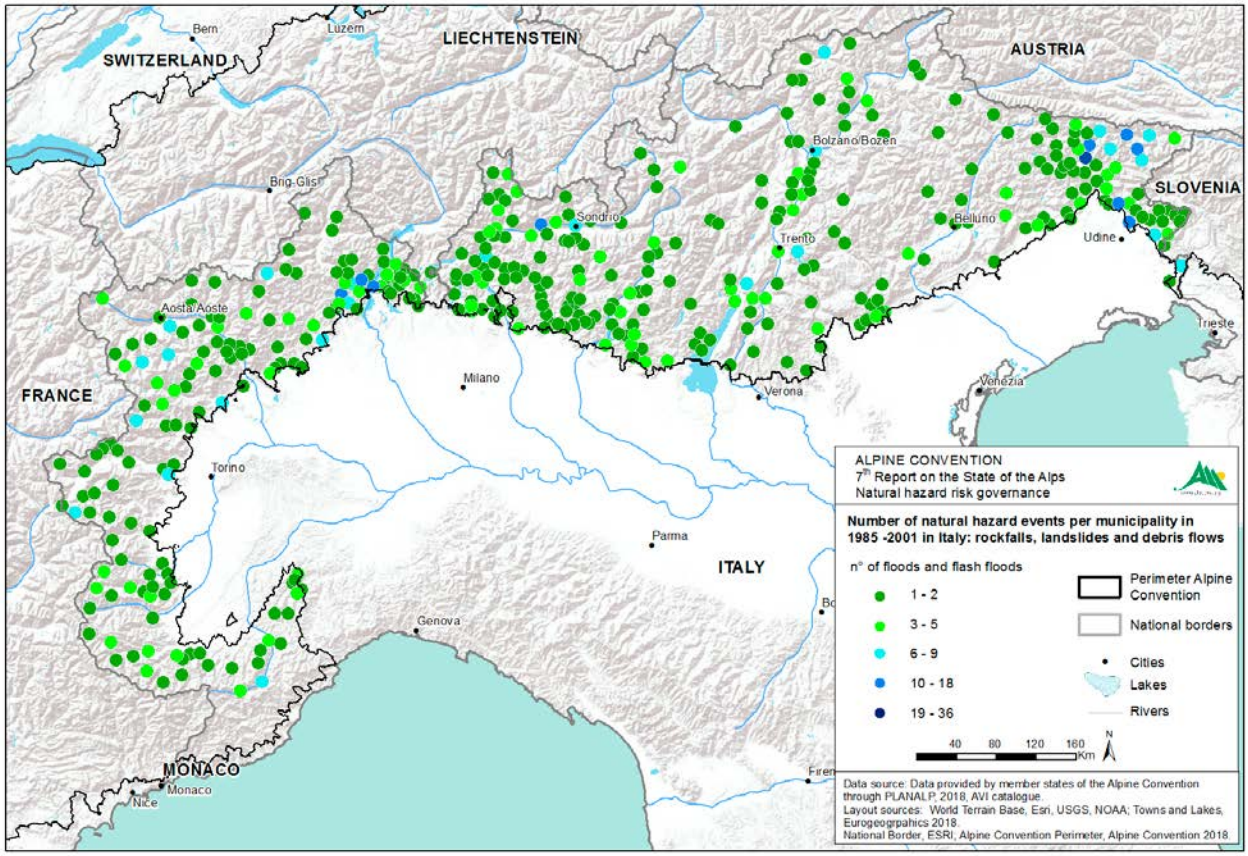

Figure 54: Floods and flash floods in the Italian Alps in the period 1985-2001 (Source: AVI Catalogue)

All the data for these maps are taken from the AVI catalogue, a database (webmap.irpi.cnr.it/) built on bibliographic and archival sources prepared by CNR (National Council for Researches) and collecting the hazardous events occurred in the XX century. The AVI catalogue includes all the events that have injured/killed people or damaged at least a building (either residential, industrial, public or of cultural interest) or an infrastructure (either public infrastructure, public network, road or railway) from 1985 to 2001.

The map on landslides includes, for the above mentioned period and criteria, landslides, rockfalls and debris flows in all the Italian Alpine provinces (NUTS 3), except Imperia and Savona.The map on floods includes both floods and flash floods along with the same criteria and time-interval in all the Italian Alpine provinces (NUTS 3), except for Imperia and Savona.

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