Transnational collaboration in natural hazards and risk management in the Alpine Space

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1. Introduction

In the last years, natural hazards and the effects of climate changes on these natural processes became a widely discussed topic. Also the media discovered this issue. Articles and news reports about 'catastrophic' events throughout the globe became a semi-weekly contribution of the news. In fact, also the Alpine Space has been interested by natural hazard events with a superregional relevancy. Mostly prominent were the snow avalanches in Switzerland and Austria in 1999, the flood event in Piedmont and Aosta 2000, or the flood events in Switzerland and Austria in 1999 and 2005. But, in geologically young mountain areas, periodic and episodic geomorphologic processes like mass movements, floods and avalanches are common natural processes. Only the exposure of people, mobile and immobile values and infrastructure to these natural processes makes these processes be hazards or even catastrophes. The increase in the frequency of newspaper articles and news reports informing about disasters caused by natural hazards may lead to the conclusion that there is a general increase in the frequency of natural hazards. These feelings are supported by the re-insurance companies that document a world-wide trend of growing risks associated with natural hazards. Often intuitively, the effects of climate changes are made responsible for this 'observed' increase in the frequency of natural hazards.

The explanation for this 'noted' increase in the frequency and severity of disasters caused by natural hazards could not be a simple one. An explanation for this may be a variety of complex changes, both in the human environment and in the natural environment. On one side, growing population density and increased needs for mobility lead to the spread of settlements, infrastructure, facilities for industry and tourism towards endangered areas. On the other side, there had been observed an intensification of some process dynamics of natural hazards due to changing climatic conditions. The resulting rapid changes in both, the number of exposed people and value of goods and the characteristics of natural hazards require a new approach of managing this complex system of risk and safety.

This rapid changing risk situation is not manageable by a public institution alone or by a single discipline. The factors influencing risk situations are so vast and inter-dependent that many disciplines and institutions deal with natural hazard and risk management. Risk management is a composite responsibility of public institutions either on national, regional or local level and of the private sector.

Recently, natural hazards risk management practice is facing challenges such as the consideration of the effects of climate change, the rapid evolvement of damage potential or the strong decrease in acceptability of natural risks by the public. Therefore, risk management practice is subject to an ongoing optimization process. Due to the variety of actors and due to need for interconnection and coordination of the efforts of many disciplines, the advances in natural hazards risk management are not based on few innovations but on the optimization of the interfaces between all activities in risk management.

This chapter aims at presenting a state of the art of these efforts in optimizing risk management practice. Due to this focus, this chapter follows a practical view rather than a purely scientific approach. The focal point laid on the effects of climate changes on natural hazards and risk management practice.

1.1 Integrated natural hazard and risk management

Risk management is the process of finding solutions for the reduction of unaccepted risks. Risk management in dealing with natural hazard in a wider sense is part of the holistic understanding and consideration of natural risks, composed by risk analysis, risk evaluation and risk reduction or risk management in a narrower sense. In a risk analysis, the potential hazards are identified and valuated, and the damages and other consequences are assessed. In a risk evaluation procedure, the results of a risk analysis are evaluated by comparing the calculated risk with other risks, and by discussing the acceptability. Normally, this process is done be the legislation of the states.

The practice of integrated risk could be divided in four main phases. It is assumed that natural hazards are periodic events that occur temporarily with smaller or greater dimensions. The *preparation phase* consists of prevention work, of preparation efforts for crisis management and early warning before an event. Prevention usually is made by land use planning measures, by technical measures and biological measures. The preparation for the crisis management consists of the elaboration of civil protection plans, of crisis management plans, or resources management plans and exercises of the responsible emergency management units. Early warning systems support the increase of the preparedness and allow reducing the expected damages by the implementation of temporarily measures. During and shortly after the event *response activities* will be initiated. Intervention measures aim at managing the event itself and at reducing the expected damages or consequences. After the event, recondition measures aim at repairing provisionally the most important damaged infrastructures, supply and communication systems. The *reconstruction phase* consists of the reconstruction of damaged infrastructures in a less vulnerable way, the strengthening of resilience and the financing of recovery activities. The analyses of the event support the enhancement of risk management by learning from errors made in previous prevention measures, in hazard evaluation or in crisis management.

Fig. 1. Activities and phases in natural hazards risk management. Source: ClimChAlp (2008)

The practice of integrated risk management is an interconnected and coordinated effort of many actors and institutions. Therefore, natural hazards and risk management requires the collaboration and coordination of a number of actors on different administrative levels. All responsibilities and actions have to be coordinated and have to be complement to each other. The coordination across different administrative areas is called horizontal cooperation. The coordination of tasks in risk management between different administrative levels is called vertical cooperation.

In recent years, a fundamental shift in the paradigms for dealing with natural hazards and related risks could be observed throughout the Alps. The increase of complexity of risk situations and the extent of damages at the one side and the limited financial resources at the other side lead to the development of a new approach. The focus in natural hazard was brought from the defence against natural hazards by the construction of protective measures as the principal solution of risk mitigation to a more holistic approach, considering risk management as integration of a variety of single activities (PLANAT 2004). This change of paradigms started at the end of the 1980ies with the Italian law of integrated watershed management and had been significantly stipulated by the Swiss guidelines prescribing the requirements for planning of risk reduction measures on the basis of risk analyses. Further steps were the Italian decree of risk based land use planning of 1998 and the Swiss guidelines for risk analysis and risk based decision making in the planning of protection measures in 1998.

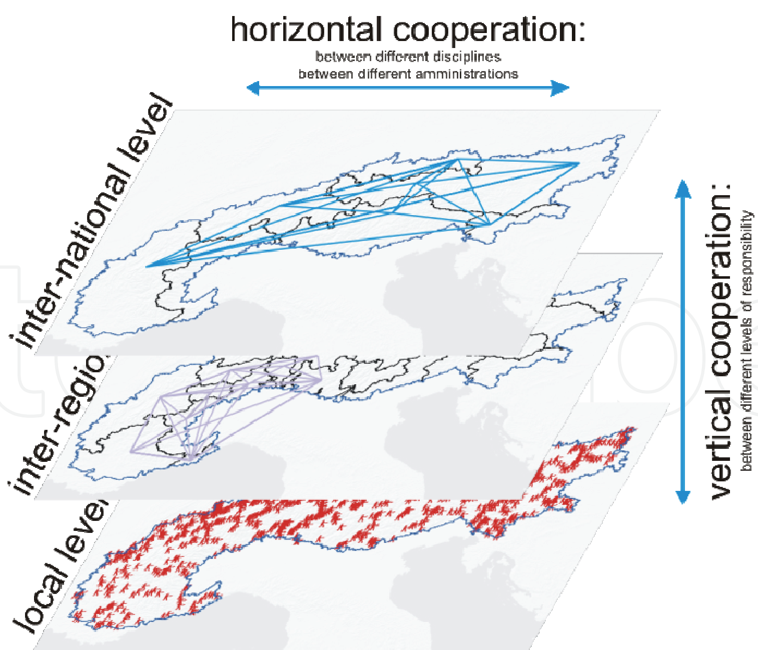

Fig. 2. Horizontal and vertical cooperation in natural hazards and risk management

1.2 Effects of climatic changes on natural hazards

The assessment of dangerous processes and the delimitation of hazard zones is a fundamental task in risk analysis and risk management. In general, the assessment and evaluation of geomorphologic processes and hazards could be made using the reconstruction of historical processes (backward directed indication) or using simulation models (forward directed indication, Kienholz et al. 2004). In practice, both approaches mostly are combined. Usually, the hazard assessment is made for the actual state of the studied system (e.g. torrent catchment, landslide area, etc.). Natural hazards are described by the process intensity of a given design event with a certain reoccurrence interval (e.g. 30, 100, 300 years). The actual system status is described by the system behaviour of the last decades.

Due to impacts of climate changes, either slight changes in the future system or non-linear system changes could be assumed. Once changes in the environmental system occurred, the future geomorphologic processes must not occur exactly in the same way as in the past. E.g. shifts in altitude levels or system constellations never observed before could be expected. Thus, backward directed indication of natural hazards and the interpretation of the past geomorphologic processes also named as "silent witnesses" and statistical analyses of time series for assessing actual processes will increasingly be subjected to uncertainties. Past observation data (e.g. precipitation data series) could probably not represent the future system status. As a consequence, the statistically described natural hazard situation and the reoccurrence intervals of design flood discharges or design parameters for the planning of hydraulic protection structures could only partially be valid under future climate conditions (e.g. Caspary 1996, 2004, Caspary and Bardossy 1995, Bardossy and Pakosch 2005, Frei et al. 2006, Katzenberger 2004, Hennegriff et al. 2006).

But, most of the decisions made in risk prevention have to be made for a period of almost 30-50 years. E.g. hazard zone maps do influence land use planning over a long period. In Austria or in Switzerland, some of the hazard zone maps made in the 1980ies are still now valid documents for land use planning. Technical construction measures such as river dams or flood retention basins have an average lifespan of almost 50 years. In practice, today's decisions for long-term risk management activities such as the planning of technical protection measures do not consider the future system status but are reactions after damaging events.

Because of these practices in risk management, the deduction of the most critical factors for hazard assessment under changing environmental conditions is relatively obvious: At least for natural hazards related to precipitation, the most relevant changes in the environmental parameters due to climatic changes are to be expected in the intensity/frequency relation of precipitation events (rainfall, snowfall). Indirect effects are shifts in altitude levels due to rising temperatures, e.g. rising of the altitude of the limit between snowfall and rainfall or rising of the lower boundary of permafrost zones. Seasonal and regional changes in precipitation patterns are to be expected as follows: In Autumn, extreme values for daily precipitations are expected to increase by 10% in the Northern Alps and by 20% in the Southern Alps. In winter and spring, an increase between 0% and 20% is expected for both regions (KOHS 2007). Brunetti et al. (2001) observed a trend for an increase in frequency of extreme precipitation events in Northeastern Italy. Under the most unfavourable conditions, a 100-year event of today could in the future become a 20-year event (Frei et al. 2006). Similar trends were calculated for the rivers Donau, Enz, Kocher and Alp in South West Germany (Caspary 2004). Caspary (2004) underlines that the discharge regimes of these rivers show statistical instationarities in their time series because of the relative accumulation of extreme events since the 1990ies. E.g. a discharge event with a reoccurrence interval of 100 years in the reference period 1932-1976 of the river Enz at the gauge of Pforzheim equals a discharge event with a reoccurrence interval of 30 years in the reference period 1932-2002. Remarkably increases in runoff and discharge volumes were also computed for the Lavanttal region (Austria) when considering possible effects of climate changes (Regional Office of Carinthia, Department of Water Economy 2008).

An indirect effect of the increase of mean temperature is the rising altitude level for the limit between rainfall and snowfall. In areas of the Northern Alps below 1500 m a.s.l., an increase of flood peaks is expected in winter due to higher soil water contents, the rising of the rainfall/snowfall limit level and due to an increased percentage of liquid precipitation to the total sum of precipitation (KOHS 2007). In the pre-Alpine regions, the increase of precipitation in winter and the rising of the snowfall limit will have consequences for the activities of landslides in winter and spring. The increase in soil saturation leads to an increase in landslide activity and to an increase in sediment load in alpine torrent catchments. Due to the rising altitude level of glacier retreat areas and areas of permafrost degradation, the sediment transport in the areas between approximately 2300 and 2800 m a.s.l. is expected to increase (KOHS 2007). Since in these areas more precipitation will fall in liquid form, this trend is expected to be remarkably.

From the discussions of experts for hazard zone mapping in different workshops resulted, that the following climatological parameters used in the assessment of flood and debris flow hazards are at most sensitive to climate changes (Staffler et al. 2008)

- Intensity of precipitation
- Frequency of precipitation of a certain intensity/magnitude

Other parameters such as the altitude of snowfall limit, the altitude of snowmelt level, the antecedent precipitation, the retreating of glaciers or the degradation of permafrost are considered only in a generalized way in the common procedures for hazard zone mapping. Certain parameters needed for hazard mapping are assumed as worst case scenarios, e.g. the assumption that the altitude of the limit between snowfall and rainfall during extreme precipitation events is higher than the mountain crests and all precipitation contributes to runoff.

If potential effects of climate change on natural hazards have to be considered or not, it is not decided commonly yet. While some regions or authorities consider selected effects of climate change in hazard zone mapping and in the planning of protection measures, others neglect potential consequences respective decided to not consider these effects in common practice.

2. Advances in natural hazard risk management practice in the Alps by transnational collaboration

The 'catastrophic' events in the recent years showed some weaknesses of risk management practice in the Alps. The challenges for improving natural hazards and risk management are manifold. The economic development leads to a spread of settlements and infrastructure towards endangered zones. In the same time, the values of houses and goods and the requirements for mobility are increasing. This leads to an increased dependency of human activities on the continuous functioning of infrastructures and therefore to an increase of the vulnerability against natural hazards. Society is increasingly demanding for absolute safety in the topic of natural hazards, while individual responsibility is increasingly denied. The higher demands for higher safety standards will lead to an increased pressure to public finances. With or without the effects of climate changes on natural hazards, the challenges to natural hazards and risk management practice are enormous. Some tasks could not be faced by single institution alone; solutions must follow a common strategy. The development of a strategic vision for confronting these challenges and setting the framework for implementing this strategy could be made only within a collaborative framework.

In the Alps, the development of solutions and strategies for confronting the challenges for natural hazard management is made on different levels. On a strategic level exists a working group of the Alpine Convention, the Platform on Natural Hazards of the Alpine Convention PLANALP. The exchange of information and experiences on the level of research institutions and regional authorities is made via the International Research Society INTERPRAEVENT. The common development of innovative approaches and the harmonization of practices and data standards are made on the level of transnational projects with funding by the EU.

2.1 PLANALP – Platform on Natural Hazards of the Alpine Convention

After the devastating avalanches and floods of 1999, the Alpine Conference founded a working group ("Avalanches, floods, debris flows and landslides") which had to develop common strategies and activity fields in natural hazards and risk management on the level of the member states of the Alpine Convention. Based on the recommendations of this working group (Greminger 2003a, Greminger 2003b), the "Platform on Natural Hazards – PLANALP" was appointed by the Ministers of the Member States in 2004. The mandate of PLANALP covers both the formulation of strategic concepts on integrated risk management against natural hazards and the coordinated implementation of subsequent recommendations. The contracting parties of the Alpine Convention delegated high-level experts to the working group PLANALP in order to ensure effective networking and coordination of activities in the Alpine region and exert influence on national strategies. PLANALP works closely with the relevant professional international and national institutions in this field. The platform consists of between 16 and 20 member. Observers to the Convention may put forward two representatives selected by the observers themselves. PLANALP meets at least once a year in the country that holds the chair.

The activities of the working group should focus mainly on concepts for integrated measures for risk reduction and the coordinated implementation of subsequent recommendations for policy-makers. The working group is appointed to encourage and enhance the exchange of experiences in risk management between the member states of the Alpine Convention by collecting and promoting "best practice examples" and by sharing decision bases for the implementation of measures for risk reduction.

The PLANALP has the competency of answering the most strategic questions and therefore contributes to the advances in risk management practice on strategic level. The first output of the working group was a guideline for the documentation of alpine natural hazard events, elaborated on the basis of the results of a transnational project (Permanent Secretariat of the Alpine Convention 2006). In 2010, the PLANALP published recommendations for the improvement of natural hazard risk management practice (PLANALP 2010). The later summarizes the actual challenges that risk management practice is facing because of the effects of climate changes and defines recommendations on how to meet these challenges.

2.2 INTERPRAEVENT – International Research Society

In 1965 and 1966, different regions in Europe were hit by several flood disasters. The devastating events led to regular meetings of experts in flood protection in Klagenfurt in 1967, to discuss the causes of these natural occurrences, as well as preventive measures for protection and damage limitation. These expert meetings were institutionalized by the foundation of the "Research Association for Preventive Action against Flooding ". This association aimed to provide a forum for supporting scientists, practitioners and experts to analyze the causes of flooding and develop protective plans and strategies. The Association also placed great importance on encouraging applied research at universities, experimental stations and building authorities, and regularly spoke out to awaken interest and sensitize the public concerning this issue. In 1990, the association was renamed "The International Research Society INTERPRAEVENT".

The International Research Society INTERPRAEVENT aims at defining strategies and concepts for preventive protection against disasters and at supporting interdisciplinary research to protect our living space against flooding, debris flow, avalanches and mass movements. The intention is to carry out research and transfer information and expert knowledge concerning the causes of catastrophic events to practice. Recently, the website of INTERPRAEVENT offers a service for searching and downloading all the paper of the conference proceedings. The sum of all these papers is a close image of the development of risk management practice in the Alps and related countries and a set of good practice examples. The website offers also a tool for searching and offering possibilities for the temporary exchange of practitioners interested in learning from other institutions specialized in a specific task.

The INTERPRAEVENT has the competency of transferring knowledge from science to practice and therefore contributes to the advances in risk management by shorten the time lag between new scientific findings and their implementation into practice.

2.3 Transnational projects

Beside the institutional cooperation between the member states on ministerial level, the transnational projects and especially the transnational projects co-funded by the Alpine Space programme are another approach for building a collaborative network in the Alpine Space and for optimizing risk management practice. While the approach of collaboration on ministerial level follows a top down approach, most of the transnational projects follow a bottom-up approach. Some of the Alpine Space projects follow a strategic approach. These projects aim at developing a commonly accepted strategy for dealing with common problems. Therefore, these projects require a wider field of project partners. The Platform on Natural Hazards of the Alpine Convention supports the design and formulation of strategic projects. The projects are implemented by the project partners, but some of them are strongly coordinated with the PLANALP.

ClimChAlp - Climate Change, Impacts and Adaptation Strategies in the Alpine Space

One of the past projects with a strategic focus was the Interreg Alpine Space 2000-2006 project "ClimChAlp - Climate Change, Impacts and Adaptation Strategies in the Alpine Space". The most important purposes of this project were to support the political decisions regarding the protection and control over the natural disasters connected with the phenomena of climate changes. The lead partner of the project was the Ministry for the Environment of Bavaria. The project started in March 2006 and was concluded in December 2008. Each member of the working group elaborated a state-of-the-art report in risk management practice in his region. Such reports had been elaborated for the regions Rhône-Alpes, Aosta Valley, South Tyrol, Bavaria, Carinthia, Vorarlberg, Nidwalden, Ticino, and Valais. Reports about the legislative context and about the administrative responsibilities on national level were elaborated for the countries Austria, France, Germany, Italy, and Switzerland.

The content of these reports were implemented into the PLANALP-DB database and provided the basis for the analysis of the weaknesses and strengths in risk management practice in the Alpine Space. PLANALP-DB is a database tool which helps to get and compare detailed information about the legislative framework and about the organizations involved in natural hazards and risk management in the Alpine Space. The database points out guidelines, successful practices, good examples and actual problems in facing the effects of climate change regarding to the practices in risk management. The content can be accessed by a graphical user interface via the website of the AdaptAlp project (www.adaptalp.org → links → PLANALP DB). The content is searchable by a territorial filter, by an information tree or by keyword search. With this structure, either all information of the risk management practice in a single region or the selected topics of risk management in more regions could be viewed and analyzed.

A SWOT analysis (strengths, weaknesses, opportunities, threats) of the partner situations was carried out to establish the state-of-the-art of natural hazard risk management. The following summarizes the main conclusions of this analysis (Greminger et al. 2008).

- In general, the existing legislation does not foster the individual responsibility of citizens in the minimization of the risks posed by natural hazards. The discussion of possibilities for the promotion of the individual responsibility of the general public in relation to natural hazards on an international cross-border level could help in achieving progress in this area.
- The collaboration between the avalanche warning services of the Alpine regions and the sharing of measured meteorological and nivological data for avalanche warning purposes is a good practice for the implementation of similar collaboration in flood warning services and other early warning systems.
- Trans-regional collaboration will reduce the time required for the implementation of instruments which are already routinely used in other regions and countries.
- The promotion of knowledge of endangerment and risk awareness on an international cross-border level increases national and regional efforts in the area of integrated natural hazard risk management.
- The potential of knowledge in the alpine space is underestimated in the daily work on a strategic as well as on an operational level.
- Creation or reinforcement of observation networks and the implementation of pilot test sites on an international cross-border level improves the quality of both information and cooperation.
- Disasters of international importance require international co-operation and interdisciplinary solutions. Thus, the contact at scientific and administrative level between the national and international institutions and authorities involved in the field of natural hazard management must be intensified. Important tasks here include the transfer of knowledge and international support during natural disasters.

The following activities have been identified as priorities for cross-border cooperation:

- Fostering of the integrated watershed management approach and the consideration of integrated natural hazards and risk management strategies in all planning processes relating to land-use and the use of natural resources.
- Implementation of hazard zone maps in land-use planning and land use management
- Promotion of local object protection measures and individual responsibility in relation to natural hazards
- Further development of the already successful coordination and collaboration between all responsible institutions at both regional and transnational level.
- Increasing the involvement of the public in the planning of permanent mitigation measures, improvement of the individual responsibility and of the awareness of populations in establishing a culture of safety and resilience at all levels.
- Reinforcement of disaster preparedness through local emergency training. Elaboration of strategies for the reinstatement activities during and after an extreme event.
- Improvement of early warning services.
- Enforcement of sustainable solutions in the context of protection and risk reduction strategies. Consideration of damage potential, risk analysis and cost-benefit analyses in integrated risk management. Planning of permanent protective measures on the basis of a list of priorities over a long-term planning period rather than as reactions to events that cause damage.

- Integration of a multi-risk approach in the territory developments.

Within this project, two case studies for the analysis of the effects of climate changes to the extent of hazard zone maps have been made (Staffler et al. 2008). In one case study have been analysed the consequences of a potential increase of precipitation intensity of about 20% to the extent of the flood hazard maps and in the second case study have been analysed the consequences of this assumption to the extent of debris flow hazard maps. The two case studies showed a remarkable increase of the areas affected by floods and debris flow when considering possible future precipitation intensities in hazard mapping. The analyses of the possible impacts of climate changes showed that the flooded areas of a design event with a return period of 30 years representing the assumed future climate conditions have a larger extent than the flooded areas of a design event with a return period of 100 years representing the actual climate conditions. The expected damages of a flood event with a return period of 100 years increased up to 207% and up to 117% for an event with a return period of 200 years. But, the calculated increase in extent of future hazard zones lay within the uncertainty of the methods used today for the delimitation of the hazard zones. Thus, the consideration of the uncertainties laying in the methods for the elaboration of hazard zone maps in the torrent and river catchments sensitive to climate changes would provide a useful instrument for the consideration of potential future climate conditions. The study demonstrated that weak points in protection structures in future will become more important in risk management activities. This means that the stress-strain behaviour of these weak points in cases of discharges exceeding the channel capacity must be studied.

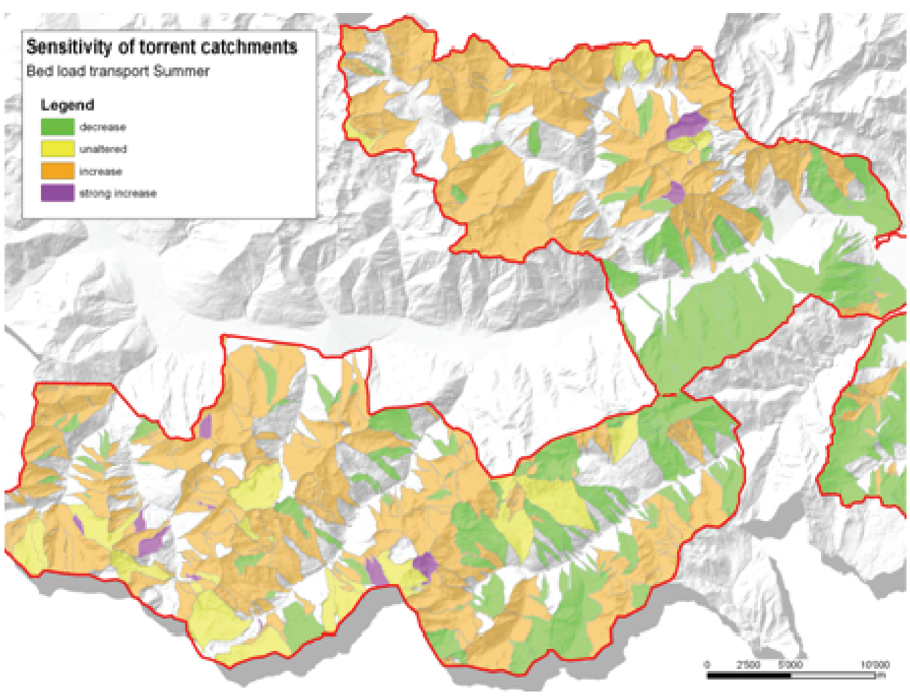

Fig. 3. Sensitivity of torrent catchments against climate changes. Bed load transport in summer. Example from the Autonomous Province of Bolzano, Italy (Staffler et al. 2008).

Another contribution of the project to the discussion if the effects of climate change have to be considered in hazard assessment or not was the development of a procedure for the identification of Alpine torrent catchments that are sensitive to selected effects of climatic changes (Staffler et al. 2008) on a regional scale. The first step of the procedure was to match the environmental parameters relevant for hazard assessment on the regional scale with the existing spatial datasets. On the basis of the identified parameters and the existing datasets, an approach for the classification of the torrent catchments of different dimensions and for the qualitative assessment of the sensitivity of the catchments against assumed climatic changes was developed. The delimitated torrent, torrential river and river catchment areas were classified by the combination of these factors influencing the sensitivity of mountain torrents and rivers to climate changes. The classification was made by means of a decision tree implemented into a GIS-based procedure. The results of the classification procedure are different classes of torrent and river catchments reacting in different ways to potential climate changes.

The results of the approach for assessing and classifying the sensitivity of mountain torrent and torrential river catchments against the assumed climate changes showed WHERE the future scenarios of natural hazards are expected to occur more likely. The analyses pointed out that the impacts of climate changes to the hazard situation of torrential and river systems are varying spatially. The identification and localization of the torrent catchments, where unfavourable changes in the hazard situation occur could eliminate speculative and unnecessary measures against the impacts of climate changes like a general enlargement of hazard zones or a general over dimensioning of protection structures for the whole territory (e.g. as suggested by Hennegriff et al. 2006). Thus, the procedure could support the discussion about future strategies for adaptation to alternated climate conditions by providing the trends for the development of the hazard situation in a higher spatial resolution. It is exemplarily shown that only for about 4% of the settlement areas an increase of debris flow activity due to permafrost degradation is relevant. But, the environmental changes in the starting areas of the debris flows endangering these sensitive areas must be observed and monitored. In these catchments, the sediment management in alpine torrents will meet future challenges due to a higher rate for sediment removal from retention basins.
Together with the consideration of the affected damage potential, the procedure for the identification and localisation of alpine torrent and torrential river catchments which are sensitive to climate changes provide an information basis for the identification of these cases, where the risk potential tends to increase. Because the impacts of climate changes to natural hazards show remarkably regional differences, the knowledge about where the expected changes in the natural hazard situation have consequences to the risk situation is crucial for the consideration of the impacts of climate change in land use planning and risk management.

AdaptAlp – Adaptation to climate changes in the Alpine Space

AdaptAlp is a European project funded by the Alpine Space programme under the European Territorial Cooperation 2007-2013. The project seeks to contribute to the question of how to adapt to the risks of natural hazards in a changing environment in the highly complex and sensitive Alpine Space.
The project consortium will (1) improve the data basis for the entire Alps with special focus on climate scenarios and hydrological data, (2) harmonize methods and procedures in the field of hazard mapping, (3) disseminate information on risks by means of publications,

expert hearings and tools, and (4) finally come up with recommendations for an enhanced disaster management and adaptation in the Alpine Space.
In work package “water regime” , existing data of the entire alpine region will be collected, harmonized and analysed. At the same time, new approaches relating to an assessment of the consequences of climate change regarding water resources will be tested. The expertise gained during the process will subsequently be integrated into the planning of protective measures. Additionally, models that simulate soil erosion will be tested in these areas in order to cover the most important risks linked to the water cycle. In work package “hazard mapping”, different methods of hazard zone planning applied in the alpine area are evaluated, harmonised and improved. Focus is laid on a comparison of methods for mapping geological and water risks in the individual countries. In selected model regions methods to adapt risk analysis to the impact of climate change will be tested. This should support the development of hazard zone planning towards a climate change adaptation strategy. In work package “risk prevention and risk management”, the most efficient methods will be identified for the rapid and cost-effective estimation of possible damage scenarios and risk situations in the regions and valley municipalities. The aim is to elaborate planning criteria that permit a comparison between risk conditions of different municipalities. This would support the definition of priorities for measurement packages and individual measures. Employment of a database covering the entire alpine area and examples of “best practice” (those taken from practical experience) will be included so that other practitioners can refer to them for orientation. In addition, and on the basis of these examples, expert hearings will be held and a series of recommendations for practical implementations will be elaborated. One focus in this context will centre on strategies to deal with uncertainties involved in risk assessment.

PermaNET – Permafrost monitoring network
Permafrost is highly sensitive to climatic changes. Permafrost degradation and related natural hazards affect traffic routes, tourism areas, settlements and infrastructures. However, data on permafrost is spatially inconsistent and a map of the distribution of permafrost in the entire Alpine Space does not exist. Further, the relevance of subsurface ice content in rockglaciers and scree slopes for the hydrologic regime of alpine watersheds regarding water resources management is unknown. A common strategy to tackle these emerging impacts of climate change in risk prevention and territorial development does not exist. Decision makers and stakeholders need to be provided with such information to manage the consequences of climate change impacts on permafrost and the resulting natural hazards.
PermaNET is a European project funded by the Alpine Space programme under the European Territorial Cooperation 2007-2013. The overall objective of the PermaNET project is to make an important contribution to the mitigation of natural hazards that result from climate change impacts on alpine permafrost. Through the creation of an alpine-wide monitoring network and by developing a common strategy for dealing with permafrost related hazards PermaNET contributes to sustainable development and the implementation of good governance practices. PermaNET will provide decision-makers and responsible authorities with the necessary decision-bases and strategies to deal with permafrost related hazards. Gaps in the data of permafrost distribution will be closed and a continuous permafrost map and database for the entire Alpine Space will be produced. New and promising technologies will be tested and joint solutions for the adaptation of risk management practices will be explored. Ultimately PermaNET will contribute to push the

Alpine Space to be the leading model region in the field of climate change mitigation and adaptation strategies in mountain regions.
The PermaNET project will produce an alpine-wide permafrost monitoring network including an information system and selected monitoring sites, a permafrost map for the entire Alpine Space and a common strategy as well as guidelines for the consideration of permafrost in risk and water resources management. PermaNET will raise awareness of decision-makers and responsible authorities to this topic and provide Alpine-wide decision-bases and strategies. The transnational cooperation (Austria, France, Germany, Italy and Switzerland) in aggregation of existing and collection of new data to produce a common permafrost dataset will reduce costs for adaptation of governance practices to specific effects of climate change. The outputs of PermaNET support decision making in planning activities in the high alpine area.

CLISP – Climate change adaptation by spatial planning in the Alpine Space
CLISP is a European project funded by the Alpine Space programme under the European Territorial Cooperation 2007-2013. The project started in September 2008 and will run until September 2011. The project is focused on the challenges to spatial planning in the face of climate change and shall contribute to climate change adaptation by providing climate-proof spatial planning solutions. CLISP is committed to positioning spatial planning as a key player for future sustainable development under the adversities of climate changeCLISP aims at preventing, reducing and mitigating climate-change related spatial conflicts, vulnerability of spatial development and spatial structures to adverse climate change impacts, and consequential damages and costs. CLISP intends to contribute to sustainable, climate-proof spatial planning and territorial development in the Alpine Space by being committed to the following main objectives:

- Developing new climate-proof planning strategies for sustainable and resilient spatial development on transnational, national and regional level.
- Developing and applying a transferable concept and methodology of regional spatial vulnerability assessment and providing knowledge of vulnerabilities in model regions.
- Evaluating the 'climate change fitness' of spatial planning systems (legal and institutional framework, instruments, procedures) and identifying strengths, weaknesses and enhancement options.
- Promoting risk governance approaches to the management of climate-related risks by conducting risk communication activities in model regions and by investigating the performance of existing risk management systems.
- Establishing a transnational expert network on spatial planning and climate change.
- Raising awareness of policy- and decision-makers, planning authorities, stakeholders and the public for climate-related risks and the need for adaptation, stimulating implementation processes, and transferring results and experiences to the entire Alpine Space and to other regions

2.4 Innovations on a regional level – the example of the Autonomous Province of Bolzano, Italy

As it is in most of the regions in the Alps, natural hazards and risk management in the Autonomous Province of Bolzano, Italy is task of many different acteurs. The most relevant role is playing the provincial authorities (regional administrative levels). These authorities are the Geological Service, the Department of Hydraulic Engineering, the Department for Civil Protection, the regional Fire Brigade, the Department for Land Use Planning and the Department of Forestry. In the recent years, the collaboration between these authorities has been intensified remarkably. The coordination between their single activities has been extended. In risk prevention, all activities of the relevant stakeholders are coordinated within the framework of the basin management plans. The elaboration of these plans is a participative process with involvement of all relevant actors of the specific area and the public. A huge effort was invested in a strong link between hazard assessment and land use planning. In the province of Bolzano, the elaborated hazard maps are inserted automatically in the local land use plan maps and therefore become binding for all territorial activities. Advances are made also in the implementation of object protection measures in cases where structural measures for influencing the hazardous process have an unfavorate cost-benefits-ratio. Object protection measures are inserted as a constraint of use in the register of real estate. This guarantees that subsequent land owners know about the long time horizon of the object protection measures. The regional authorities are working closely with other institutions in the Alps, especially through the transnational projects or within INTERPRAEVENT. Also the provision of specialized services was extended to a pool of experts from all alpine countries. The exchange with other authorities facing the same challenges and the collaborations with different experts are facilitating the acquisition and sharing of experiences and knowledge. At the moment, a weak point in the whole risk management process is a lacking expertise on local level (community) and on the decreasing acceptance of damages caused by natural hazards.

3. Conclusions

In all regions of the Alps, natural hazards risk management practice actually is facing different challenges: the effects of climate change, the rapid increase of damage potential in endangered areas, the increase of vulnerability of endangered objects, the decrease in acceptability of risks caused by natural events, and last but not least, a mismatch of increasing responsibilities of public institutions and decreasing financial resources. As these challenges in risk management affect all stakeholders in the Alpine Space nearly in the same way, a simultaneous effort in finding solutions to deal with in all states and regions in the Alps is likely to be wasted time and wasted funds. Transnational collaboration offers many possibilities for benefiting from synergies:

- Some stakeholders could find the time for specialization to an important topic while learning from other specialist in other topics of the risk management.
- Instead of finding solutions from nil, stakeholder or responsible institutions can learn from others and contribute to the further enhancement of best practices.
- Due to the limited public fonts, a transnational collaboration could make possible a satisfying budget for further developments and adaptation of risk management practice putting together many small financial budgets.

Therefore, common challenges in risk management are to be faced together. Risk management practice must base on a holistic approach combining all the available instruments and possibilities from risk prevention to land use planning and crisis management activities. In the recent years, the benefits of cross-border or transnational collaboration became evident and widely accepted. This chapter described a few examples of collaboration between borders and administrative levels. The cooperation between the different regions of the Alps leads to a variety of new findings. In the area of the Alps there exists a valuable stock of experiences: either in form of best practice examples or in form of in-deepened experiences. All regions are specialized into different tasks of the risk management; some countries are specialized in prevention works while others are well trained in intervention works. Putting together systematically the variety of approaches in natural hazards and risk management in the Alpine Space forms an immense and useful toolbox of methods for facing challenges in everyday practice. Knowledge transfer between the different specializations of the Alpine regions play a key role in adapting risk management practice to the effects of climatic changes. The variety of approaches in the Alps and transnational collaboration forms a flexible network for responding to the challenges in risk management practice. With the working group "PLANALP – Platform on natural hazards of the Alpine Convention", this variety of approaches and experiences in the Alpine Space becomes for the first time a common roof.

The described examples show that advances in natural hazard risk management practice have been made in all aspects of the risk management cycle. The instruments for facing the most challenges in risk management have been developed in international projects. The sum of all efforts in single aspects brings risk management practice a step forward. But, the permanent optimization of processes is not a valuable base for facing the most demanding challenge – the decrease of risk acceptability and of own responsibility. This challenge is to be faced in the next years.

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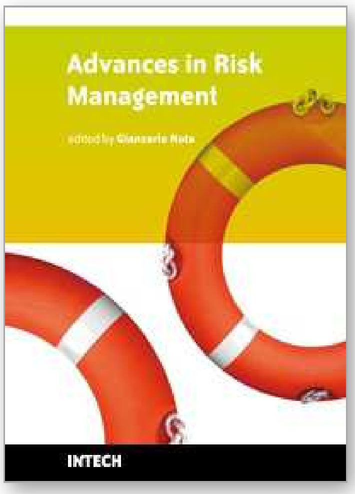

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