Meeting the risk of climate change and natural hazards in the Alps

ADVANCE

Common Strategic Paper

Alpine SPACE
KO-FINANZIERT DURCH DEN EUROPÄISCHEN FONDS FÜR REGIONALE ENTWICKLUNG
EUROPÄISCHE TERRITORIALE ZUSAMMENARBEIT
Investition in Ihre Zukunft

AdaptAlp
Adaptation to Climate Change in the Alpine Space

Point of Departure

Project Background

The project AdaptAlp contributes to a growing body of scientific research on the effect of climate change within the Alpine region and how our societies can adapt to the increasing risk of natural disasters. Our intent is to deepen this knowledge so that decision-makers can craft coherent policies and programs based on current and accurate information.

AdaptAlp is the result of three years of research—countless hours of collaboration and exchange between sixteen partners from six countries. Between 2008 and 2011, more than 130 scientists, experts and government representatives from 24 institutions worked together to understand the complex issues of climate change and natural hazards in the Alpine region.

We focused on three areas: climate change and water regime analysis, natural hazard mapping, and risk management. We wanted to put our research into action. So, in addition to developing new methods and recommendations, we also collaborated with our government partners to devise pilot projects and networking initiatives that tested these ideas.

This publication is a point of departure. It is designed to be a guide to help decision-makers and managers navigate the tricky terrain of Alpine natural hazards and climate change. For those who want to go further into the material, we have included a second resource—a fold-out poster at the back of this document, which contains more specific scientific information.

Photo: Thinkstock

Disappearing permafrost, glacial retreat, changes of vegetation cover, torrential rain, melting snow and soil erosion all contribute to events such as these.

History is kinder to those who prepare themselves for an uncertain future, than to those who react to a crisis they should have seen coming.

Moving Forward

Introduction

Examples of increasing weather extremes and natural disasters have become so prevalent that they hardly bear repeating, but it may be useful to begin with a statistic. According to a study from the insurance company Munich Re, of a total of 825 catastrophes recorded during the period 1980-2006, almost all of the € 58 bn in economic losses are attributed to extreme weather.

In the words of British historian, Ronald Wright, "each time history repeats itself, the price goes up."

In the Alps, adaptation to climate change calls for difficult decisions to be made by many interests. Given the potential cost of these decisions, government administrations must rely on current knowledge of climate scenarios and their expert interpretation to make the right choices.

While scientists believe that the climatic changes documented to date in the Alps will play a role in the occurrence of natural disasters, it is not yet possible to make a precise forecast from the available data. We cannot yet draw a complete picture of the effect climate change will have on natural hazard risks in the Alps.

In addition, the Alps have a range of physical characteristics that cause large variations in local weather conditions. This means that even more data is necessary before fully understanding the effect of climate change within each individual region.

Water Regime

Hazard Mapping

Risk Management

Example

Further Info

Knowing the Terrain

Correctly interpreting the current climate change scenarios we do have is key to knowing what adaptation strategies to adopt. So what do we know about climate change in the Alps?

We know that in the Alps the temperature rose 1.5° Celsius over the last 100 years, which is double the worldwide average. We also know that average temperatures in the Alps rose far more rapidly than climate models predicted just ten years ago. It is highly probable that we will continue to see temperatures rise in the Alps faster than is being recorded elsewhere globally.

Future precipitation is more challenging to anticipate. The average change is easier to talk about than the prediction of extremes. Agreement is generally high among climate models that in many regions of the Alps there will be a gradual increase in winter precipitation and a decrease in summer precipitation.

If and how these changes will impact our lives will vary from region to region. While some areas may be increasingly endangered by natural hazards such as floods and landslides, other regions may face problems related to water scarcity.

Even if an exact prognosis of the Alps' climatic future is not yet possible, now is the time for long-term decisions to be made regarding the adaptation to natural hazards. This is because climate change is not the only element shaping the future of the Alps. Increasing population density puts more people at peril of natural hazards and increasing property values creates a new level of economic and institutional vulnerability. Our use of land and resources also puts pressure on water availability in the summer. In fact, compared with the potential effects of climate change, these additional human factors have an even greater impact on the risk equation.

For a more in-depth explanation of how to interpret climate scenarios, please see the fold-out poster.

Meeting the Risks

The catastrophic events of recent years have revealed weaknesses in risk management practice. We can see the wisdom in the maxim: "there are costs and risks to action, but greater long-terms costs to inaction".

Today, the concept of 'vulnerability' is essential when understanding the risk of natural hazards. Assessing vulnerability in specific regions of the Alps is an integrated risk management process that has become commonplace. Putting the so-called 'integrated' approach into practice, however, is often held back by traditional ways of working. In short, we still have a way to go before we are prepared for the future:

Flexibility: We must learn to be judicious when interpreting the evolving climate change data. We must support the findings with expertise and proven tools that can keep our strategies and adaptation measures flexible over the long term.

For an explanation the integrated management process, please see the fold-out poster.

Education: We must see that educating key experts and risk-managers and the general public (especially young people) is key to creating cooperation and communication.

Collaboration: We must realise that working together across the Alpine region, harmonising our data, and sharing our experiences will help to reduce the costs and implementation time of adaptation measures.

Dialogue: We must begin to discuss the anticipated risks and decide upon possible countermeasures in a risk dialogue between experts, affected people and decision-makers.

Leaving our Mark

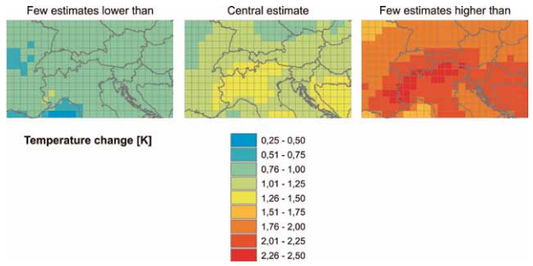
The mediatisation of catastrophes has in some ways created a positive image of emergency response: cleaning up a mess is more newsworthy than preventing it. Over time, history will inevitably show that the societies who are prepared for disasters rather than just responding to them will be held in the highest regard.

This is the legacy we should leave behind.

AdaptAlp has demonstrated that science, government and non-government organisations can advance together, addressing the climate changes occurring in the Alps and working to increase the safety of its citizens for generations to come. As stewards of the Alpine region, we cannot know where every fork in the road may lead, but with measured thinking we can find our way together.

The figure below shows the change statistics of mean annual air temperature based on a validated ensemble of 14 regional climate models for the period 2021-2050. The "low" estimate corresponds to the 10th percentile (low probability), the central estimate to the 50th percentile (high probability) and the high estimate to the 90th percentile (low probability) calculated on a 50 km grid cell basis.

Significant AdaptAlp Climate Change Findings



- Central estimates indicate that air temperature increase in the Alps will be 1.5°C by 2050 and 3.5°C by 2100.
- The continuation of the observed increase in temperature in all regions of the Alps will change the annual alpine snowfall and lead to an increase in evapotranspiration (water lost into the atmosphere from rivers, lakes plants and soil).
- Central estimates of mean precipitation show an increase of +15% in winter (+25% in the Central Alps) and -15% in summer (-25% in Mediterranean regions) towards the end of the 21st century.

Source: Federal Institute of Hydrology, Germany

Photo: Thinkstock

Strategies Preamble

In this section, we present a list of what are, according to AdaptAlp, the ten most significant actions required at this time to prepare for the risks caused by global warming in the Alps. This list is not meant to be exhaustive, nor are these actions listed in order of priority.

The ten adaptation strategies were distilled from an initial list of 100, selected from top European, national, regional and Alpine-specific climate change adaptation strategies and reports. In the unique series of meetings that went into the creation of this publication, the core scientific team of AdaptAlp identified the key Alpine issues within each strategy, and have suggested the best approach from their perspective.

With each strategy, we have included a good practice example that will give you an idea of an achievable initiative. Further examples of AdaptAlp pilot projects can be found in the fold-out poster at the back of this publication.

There is a better way. Emergency planning and preparedness are essential instruments that help the public to react more quickly to flood events. (See Strategy 1)

"Projections for the middle and the end of the of the 21st century can differ greatly and new information is becoming available all the time. Consequently, planning and implementing protection and adaptation measures should be a cyclical process in which new findings can be taken into account at regular intervals." AdaptAlp

01

Improve public preparedness and personal responsibility by encouraging participation in emergency planning.

Since safety can never fully be guaranteed in the wake of natural hazards, the public must be informed of the risks and understand its options in order to best avoid the impact on their lives and livelihood. We must establish a culture of risk and public awareness in the Alps.

At one time, this 'risk culture' in Alpine regions was more developed. Now, certain factors such as increasing population mobility from flat lands to Alpine regions and technological improvements (that give people a false sense of security) tend to weaken our risk awareness. Governments must increase efforts to communicate with the public.

Public awareness campaigns, such as accessible website information, can relate the damages and risks facing a community. Educational programs about risks and how to prevent them, particularly in schools, are another important element in the broader system of risk prevention. Building risk culture from the ground up by targeting younger audiences will save money in the long term.

To properly inform the public, risk management plans must address both ***emergency preparedness*** and ***early warning systems***. Each of these reduces 'residual risk', that is, the risk that is still present after all possible protection measures have been put into place.

Emergency preparedness provides long-term advanced warning of possible future events. This raises public awareness of endangered areas and the action plans and warning systems that are in place. Emergency preparedness planning should use resources wisely and favour holistic protection methods that can address all types of natural hazards. These measures will not only reduce the potential of damage and loss of life, but are also more cost-effective than engineered solutions. Early-warning systems, on the other hand, are interventions that happen shortly before and during the course of events in order to limit their impact. At best, they occur in phases that are tied to the escalation of a threat or event and can include the planning of intervention measures, such as the installation of temporary flood barriers, evacuation of houses or deployment of fire fighters.

Education Programme
In Austria, 'Biber Berti' has become a successful tool that teaches children about natural hazards through the use of cartoon characters. AdaptAlp created a new homepage with a special climate change focus. (www.adaptalp.org)

02

Incorporate climate change adaptation into spatial planning.

Since the 19th century, the Alps have gone through dramatic changes in the way land is used. Many factors, such as urban development, tourism and increases to property values are currently aggravating the risks posed by natural hazards. Spatial planning can navigate these changes and negotiate between competing demands on Alpine space.

Studies during the project AdaptAlp showed that there is a gap between today's knowledge of the impacts of natural hazards and the application of this knowledge in spatial planning. Such a finding is significant because although it is not possible to determine exactly how climate change will affect future natural hazard processes there is little doubt that climate change will force us to rethink the way we use space in the Alps. So when climate modelling suggests the likelihood of local impacts due to climate change, spatial planning must take them into account. Even without environmental changes, the pressures of a growing population, increased land-use, and rising property values will amplify potential risks. Previous Alpine natural disasters and their consequences have demonstrated that land-use is a key element in the growth of risk. Spatial planning can protect against natural hazards as well as reduce our vulnerability to them.

Different measures can be emphasised to create a sustainable regional development that is less vulnerable to natural hazards. A few examples are: financial incentives, establishing hazard zones, setting appropriate construction standards of buildings and infrastructure in risk areas, keeping endangered spaces free of development, and performing hazard assessments through the use of hazard mapping.

Regional Commissions
Risk of flooding motivated an original project in the Canton of Valais, Switzerland, in which the entire Rhone River plain was redesigned. The canton created "Regional Commissions" so that local interests could help in planning the redesign.
(www.persee.fr –› search term: third Rhone correction)

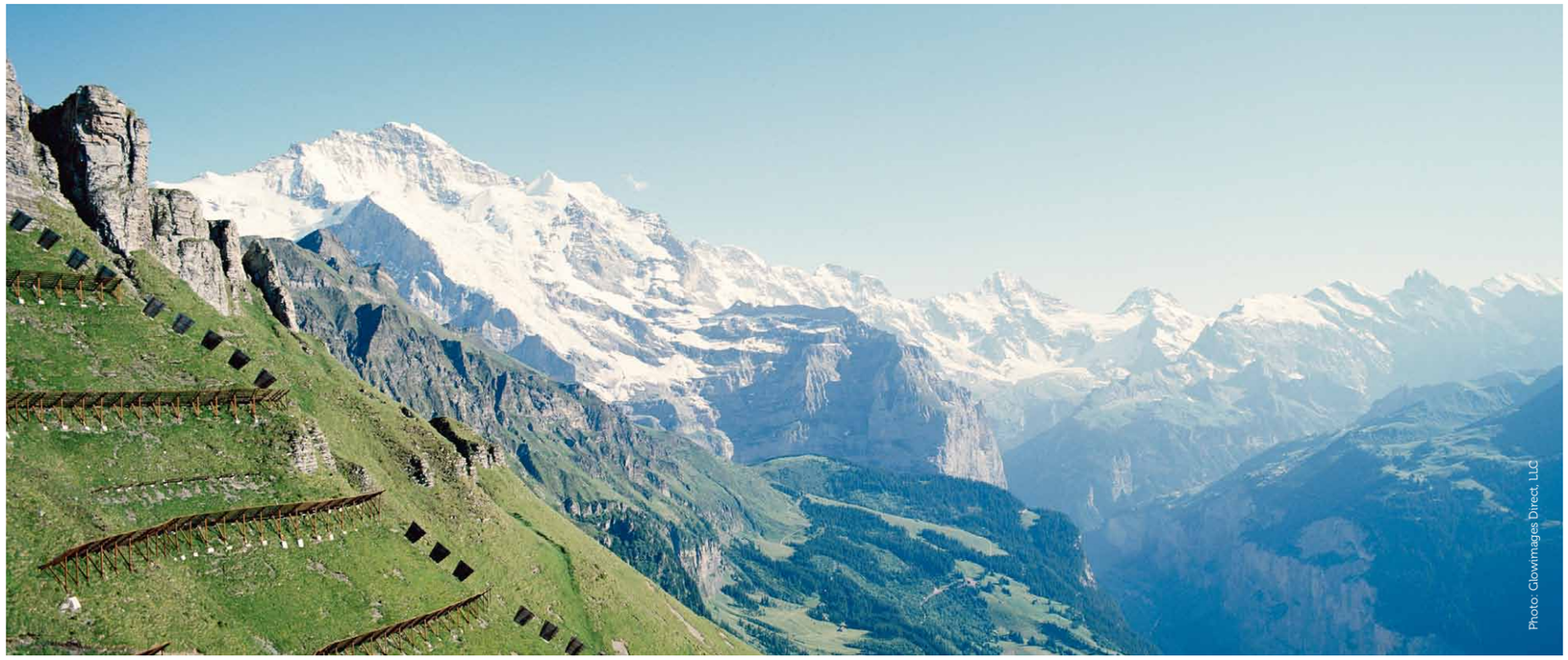


Photo: Glowimages Direct, LLC

03

Involve local stakeholders in a risk dialogue.

When dealing with climate change and natural processes and their effect on citizens, tools such as participative planning processes (in general) and risk dialogue (in particular) are of high significance.

The aim of a risk dialogue is to create the opportunity to base planning and investment decisions on the best available information. The dialogue includes meetings between important stakeholders, such as land and real estate owners, as well as those responsible for infrastructure and the public sector.

In most of the Alpine countries, the municipalities are the direct responsible institutions for the safety of citizens. This means that risk dialogue between those who make political and economic decisions, those affected by natural hazards, and those who have the relevant knowledge is inevitable. It also ensures that solutions are optimised in terms of cost-effectiveness and that the awareness of the decision-makers is increased.

This is of particular significance in cases where the information is marked by a high degree of uncertainty, as in the context of climate change. The more complex the context and less certain the data used to describe the individual hazard processes and their effects, the more holistic and broad-based the risk dialogue must be.

Risk Dialogue
AdaptAlp developed hazard maps and additional hazard analyses in Gasen and Haslau and discussed them with experts and local authorities to address future problems, in particular with regard to land-use planning.
(www.adaptalp.org –› search term: Technical Report WP7)

Traditional knowledge about dealing with natural hazards plays an important role in the development of risk prevention strategies. (See Strategy 09)

04

Encourage cross-border networking on integrated risk management.

Developing natural hazard risk management strategies across an international Alpine region requires international cooperation and interdisciplinary solutions. Contact between all those who manage natural hazards must be encouraged at both domestic and international levels.

Nearly every valley in the Alps faces the same kinds of problems when dealing with natural hazards. The solutions for these are developed locally, which results in a higher specialisation in some tasks. If these specialisations are shared, a 'toolbox' of methods can be made available for everyone who faces similar issues within their region. This will optimise the continuing development of adaptation methods. Making use of existing local, regional, national and cross-border networks of public authorities (regional planners, technicians, police, fire brigades, civil protection, policy makers and the army) improves cooperation and communication and reduces the time and cost of implementing natural risk prevention strategies. The private sector can also play an active role in these networks.

There are many ways to facilitate this communication: for example, by promoting expert hearings focused on the cross-border discussion of problems, or organising international education initiatives that address integrated risk management.

Communication Strategy
The internet platform "on_alp_exchange" is an initiative of AdaptAlp that was set up to allow practitioners, experts and technicians to exchange ideas and gain insight into the similar work of other organisations.
(www.interpraevent.at)

05

Encourage a 'common language' and harmonised procedures when developing and using hazard maps.

The importance of hazard maps as tools to assess the risk of landslides and floods is generally accepted across Europe. As a result, a large variety of maps and methods have come into use in different countries. When these countries, regions and government levels work in isolation, however, the vocabulary and procedures used to understand the problems can diverge. These differences can lead to misunderstandings and make it more difficult to exchange experiences and knowledge.

This is why experts and managers in public administration should insist on developing harmonised methods, terminologies and descriptions when producing hazard maps. When maps from different regions are synchronised, the risks become easier to compare, creating a solid foundation to make the right spatial planning decisions.

In a wider sense, this directly relates to decision-making processes on the administrative level. Everyone involved in the risk management process needs to find a 'common language' for technical terms and meanings to create a unified understanding about the goals and methods of integrated risk management.

Terminology Tool
AdaptAlp created a multilingual glossary that provides users with a selection of official terms used by the geological agencies of a specific country, along with their synonymous terms used in other countries.
(www.adaptalp.org)

"Hazard maps should not be changed in a general fashion over the whole Alpine region, only in sensitive catchment areas with obvious indications of climate change." AdaptAlp

06

Increase the size of flood plains, floodwater conduits and basins.

Creating and maintaining naturalised flood plains with indigenous vegetation is an important activity to encourage in the Alps. It is important to conserve such natural retention areas in the future, as well as to promote the preservation of forested areas in general. Not only do these plains have a moderating effect in flood situations, but they can also serve other recreational and conservational purposes that increase the quality of life in the Alps.

Of course, in severe flood events, flood plains may not alone be sufficient. Engineered water 'conduction' solutions such as dams, basins and conduits are important secondary lines of defence. Increasing their numbers in areas vulnerable to flooding, maintaining and enhancing those already in existence, and reactivating former areas are all effective ways to diminish the impact of emergency flood events.

All this is easier said than done. Space is limited in alpine regions, and there is a potential for conflicts between the uses of the land that is required for flood prevention measures. In addition, landowners can over-value the selling price of their property. Regardless, 'residual risk' means that natural disasters can become a reality. Governments need to consider multiple uses of the same land and consider strict legal binding instruments that ensure a priority for flood retention areas is given.

AdaptAlp research has demonstrated the need to take sedimentary deposits and wood debris into account when calculating the space required for flood retention. The potentially higher intensities in winter precipitation due to climate change and the projected shift of floods means that higher amounts of sediment could also affect areas prone to flooding.

Sustainable Solutions
The River Gail in Carinthia consists of a 'pearl chain' of natural retention areas that have been optimised through technical constructions. In a flood event, these areas fill up to limit the peak flow in the city of Villach. After the event, the retention areas are automatically drained.
(www.adaptalp.org –› search term: river gail)

07

Think of flood risk management in terms of an entire river basin to find solutions that are sustainable.

To improve efficiency in our approach to natural hazard risks, we need to change our thinking and recognise the synergies between all the uses of a natural resource. A wise doctor looks at the health of a whole patient rather than treating a single symptom in isolation. Similarly, in water management, a holistic view will allow us to look beyond political borders and sectoral divisions towards a single system that encompasses a whole river basin. A river basin, like the patient's body, is a complex system, which, if managed sustainably, can be highly resilient.

Such a practice is also the most cost-effective: There is little benefit to planning a water conservation program in one region, if 20 kilometres upstream water is being diverted excessively to generate hydroelectric power.

Working in partnership, we can see the big picture and find ways to get the most out of each protection measure. Flood protection activities can improve the local ecology by creating naturalised water retention areas, creating new recreation areas for tourism, stabilising the groundwater level and improving the water supply to a region.

To achieve this level of common synergy and ensure the efficiency and wise use of resources, AdaptAlp believes that horizontal and vertical cooperation between all levels of government and the private sector are essential.

Legislation

In Italy, integrated watershed management has been legislated since 1989. In the 1990s, other countries followed suit. Their experiences with this approach have shown that an efficient and continuous coordination between all relevant territorial planning activities is a precondition for success. **(www.isprambiente.gov.it/site/it-IT/Temi/Acqua/)**

08

When planning for natural hazard risks consider all the environmental risks within a defined area.

For the most part, current hazard planning practices consider hazard types separately. For example, most existing landslide maps have been developed independently from flood maps. AdaptAlp recommends a multi-hazard view. Natural hazards—floods, droughts, landslides—generate risks that are interrelated and so should be addressed jointly.

This requires coordinated action among different planning sectors. Synergies must be created between all public sectors involved in risk prevention so that the proposed solutions will serve everyone involved. Careful coordination of the entire risk management process is something that should be institutionalised and intensified.

Appointing a specific institution, organisation or person to facilitate the coordination of all activities is an effective way to assure a cohesive organisation of integrated risk management.

Photo: AdaptAlp

Cross-border, intersectoral cooperation creates cost-effective and efficient adaptation measures. (See Strategy 04)

Fact Sheets

AdaptAlp performed a comparative analysis of the buildings and infrastructures exposed to different kinds of natural hazards for all the communities of Carinthia, Austria. The results have been presented as Fact Sheets that show the risk portfolio of each community. **(www.adaptalp.org –› search term: fact sheet carinthia)**

09

Use risk-management tools to explore the social and economic consequences of various adaptation measures.

Planning for natural hazard risks calls not only for a careful study of a region's vulnerabilities, but also for a comparison of the costs of prevention measures versus the potential cost of damage after an event. Finding the ideal balance between the two is at the heart of risk reduction.

Risk planning tools help evaluate different risk prevention strategies by balancing three components: natural hazards, technology and society. These tools allow for the integration of a wide range of strategies that reduce the risks of natural hazards, including spatial planning instruments, technical protection structures, specific protection measures for individual buildings and early-warning systems.

Risk planning tools do not suggest a 'best solution'. Rather, they point users in a particular direction and help to clarify local knowledge. The results of risk and cost-benefit analyses can be shown in a simple manner, such as easy to read graphs. This data must then be interpreted, which promotes a 'risk dialogue' process of decision-making.

Experts from various fields, local decision-makers and residents are invited to workshops to discuss the findings of the analysis. The various agencies involved in this exchange—hydraulic engineers, natural hazard experts, politicians, officials, insurers and representatives of the emergency services—form a culture of cooperation. The tools help combine local and regional knowledge with expert knowledge to increase the overall knowledge base for hazards that is specific to the needs of each region. Within a set of possible risk reduction measures, the most efficient combination of measures can then be determined.

Management Tools

Pilot projects run during AdaptAlp looked at the Swiss-developed software RiskPlan, a calculation and management tool that assesses natural hazard risks and suggests avenues of cost-effective risk reduction measures. **(www.riskplan.admin.ch)**

"When observations indicate that climate change or other factors are causing an increase of natural risks, these risks should be managed through a holistic process of integrated risk management." AdaptAlp

10

Support the collection and interpretation of local climate change data.

Climate scenarios, particularly in terms of temperature increases, have shown themselves to be useful in projecting future possible consequences of climate change. They aim to give the general public a concrete idea of possible impacts, and provide a possible time-line. Without these scenarios, it would be very difficult to have a risk dialogue about the potential consequences of climate change.

The downside of climate modelling and monitoring, which are used as a basis for understanding the effect of climate change, is that they struggle to capture local effects and processes. The detail of information required to understand hydrological and meteorological processes is tremendous. This is particularly true in the Alps, as meteorological conditions can differ dramatically from one region to another according to differences in the physical characteristics of the land.

One important result to come out of AdaptAlp was a confirmation that when scientists use higher resolution data in climate simulations and impact modelling, they can create a more realistic projection for areas within the Alpine Space. Of course, it must be noted that as the detail of the data increases, so does the margin of uncertainty of the projections.

To get an accurate picture of the future climate of the Alps, scientists require more data at a local level, and data that is collected in the same way (i.e. with the same standards) between weather stations and regions. The raw data coming from these instruments requires statistical analysis so that patterns can be highlighted for expert interpretation.

Governments must continue to support both monitoring networks and climate change research, and we must create partnerships between scientific institutions and government in order to increase the amount of hydro-meteorological data and its interpretation in the Alps.

Cost-sharing
The Bavarian Environmental Agency collaborated with the German Weather Service to increase its network of high quality weather stations in Bavaria.
(www.lfu.bayern.de –› search term: niederschlagsmessnetz)

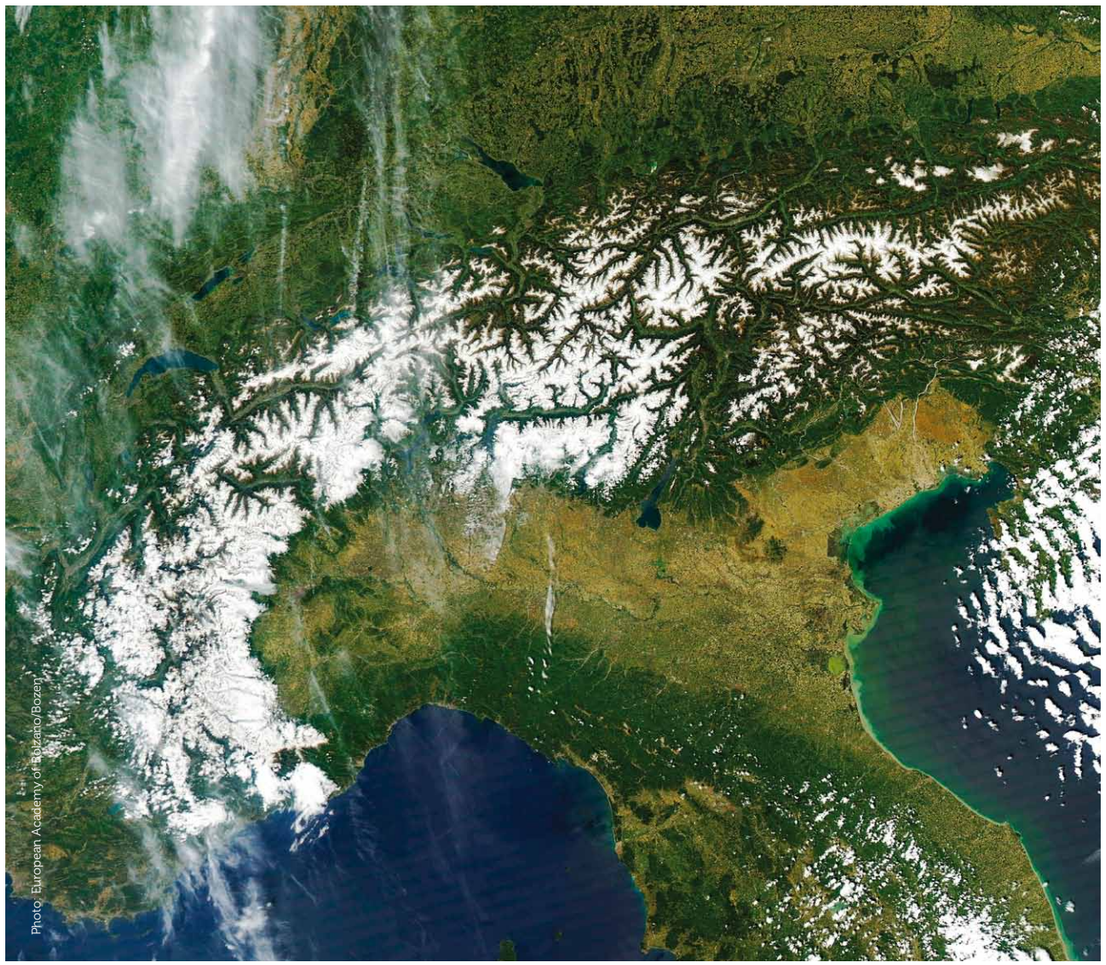
Going Further

More Information

Supporting policy with good science is the principal aim of this publication. This is why we have included a fold-out poster to help explain and expand upon some of the more complex strategies and concepts introduced in the last pages.

In the poster, you'll find summarised reports and recommendations, in-depth information on understanding climate change scenarios, and most importantly, a link to the AdaptAlp website where you can find more detailled technical documentation and resources pertinent to each of the strategies.

Satellite images such as these are one of the tools that scientists use to assess the risk of natural hazards.



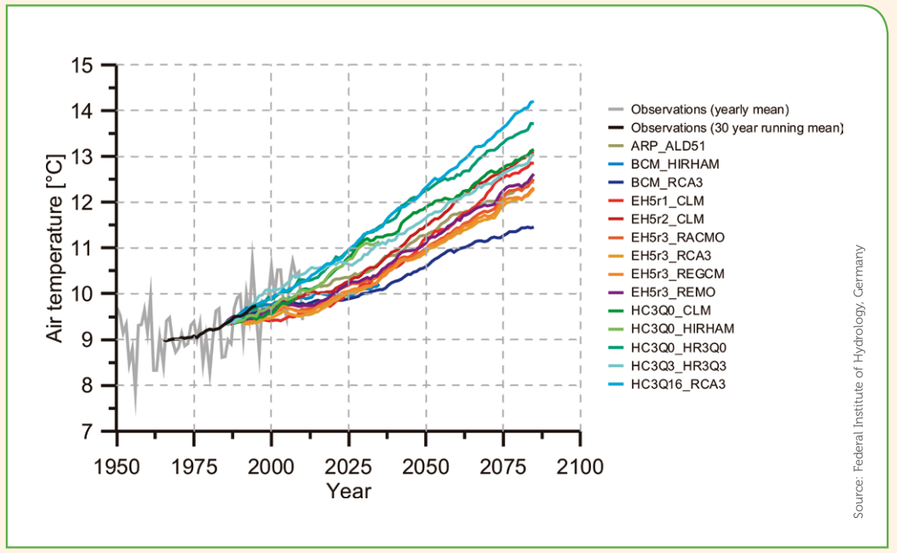
Understanding Risk Management

Integrated Risk Management

The integrated risk management of natural hazards is part of the holistic understanding of natural risks that includes risk analysis; risk evaluation and reduction; and risk management. Integrated risk management incorporates all the measures that contribute to the reduction of damage caused by natural hazards. These include, for example, emergency management during disasters, the maintenance of protective structures, repair work, the maintenance of protective forests, and structural measures.

Integrated risk management is a task that must be carried out at transnational, national, regional and local administrative levels, and requires the interconnected and coordinated effort of many actors and institutions at each administrative level. All responsibilities and actions must be coordinated and must complement each other. The aim is to make optimum use of knowledge, experience and existing data so that the potential synergy of all the institutions involved can leverage the cost-effectiveness of risk-appropriate measures. Risk communication and risk dialogue are the preconditions for the efficient coordination of the activities of all the relevant actors. Without this, the advantages of integrated risk management cannot be obtained. Risk communication and risk dialogue must be promoted and appropriate training must be provided for these methods.

Understanding Climate Change



Past and future evolution of annual mean air temperature as indicated by observations (1950-2010) and an ensemble of RCMs (14 RCMs until 2050; 12 RCMs until 2100) for the Alps. RCM data have been scaled to the observations in the period 1971-2000. Data are given as 30-year running means (anchored with the central year on the time axis).

How to Interpret Climate Scenarios

The future evolution of the climate will be the result of natural variability plus current and future human impact. Neither aspect can be predicted precisely, but must be estimated on the basis of two criteria:

1. Different but plausible assumptions of human activity (i.e. socio-economic scenarios, greenhouse gas emission or concentration scenarios), and;
2. Different but plausible computer models that simulate climate variations resulting from the influence of (1) and the current state of knowledge of climate dynamics (i.e. climate projections).

In AdaptAlp, all available climate simulations were taken into consideration and integrated into a multi-model ensemble of climate projections. The AdaptAlp climate ensemble reflects a major portion of the current state of knowledge about the possible future evolution of the climate. As a consequence of these different assumptions and models, the ensemble displays a considerable range of simulated future climate changes. AdaptAlp has reduced this span by adhering to a socioeconomic scenario which would lead to intermediate greenhouse gas concentrations (SRES A1B), and evaluating and selecting the most plausible regional climate model simulations (14 out of 20 model runs were retained). The AdaptAlp climate ensemble makes it possible to assess the degree of robustness of climate change data. The term 'robustness' refers to the ability of the models to plausibly reproduce the main features of the observed climate in the 20th century and to their conformity over a clear majority of projections. It must not be confused with 'likelihood' or 'probability', which by principle cannot be determined in a scenario-based study. The ensemble of climate projections was also used to assess a range of possible impacts of climate change. AdaptAlp and other studies have generated results for the impacts of climate change on future river discharge in alpine catchments. For river discharge and climate projections the following statement applies: Changes in the mean are generally more robust than changes in extremes. This ensemble of climate and discharge projections is intended to serve as a basis for decision-making processes. It is up to the decision-maker to choose if a particular range or individual simulation from the ensemble is considered in the assessment of vulnerability and adaptation capacity

Climate Analysis Results

- Climate models are currently the only—if imperfect—tool to assess the possible consequences of increased greenhouse gas concentrations and the resulting adaptation that will be needed over the long term.
- Making use of different climate models is regarded as the best practice to identify the most robust climate change data, within a bandwidth of uncertainty.
- Until the middle of the 21st century, precipitation simulations indicate limited precipitation change. The models show no uniform direction. For the end of the century, agreement among the models is higher and indicates more pronounced seasonal changes.

AdaptAlp Results Summary

Workpackage: Water Regime

Coordinator: Jane Korck (Bavarian Environment Agency, Germany)

Work Package Description

In this work package, observed river discharge data from the entire alpine region was collected, harmonised and analysed. At the same time, new approaches relating to the assessment of the consequences of climate change with regard to water resources were tested. New methods were tested in the catchment areas of the rivers Inn, Soča and the Alpine Rhine. Additionally, models that simulate soil erosion were tested in different parts of the Alpine Space in order to address the most important risks related to the water cycle.

Summary of Results

Collectively, the studies identified different combinations of the following climate change impacts on the water regime for different regions and different time horizons:

1. An overall shift in the water regime with less summer and more winter run-off.
2. An increase in high flow volume and duration in autumn, winter and spring.
3. An increase in erosion (river bed and soil).
4. Longer or more frequent periods of drought.

Primary Recommendations

The implementation of adaptation measures based on a local analysis of vulnerability to projected changes is recommended. As the knowledge base is continuously improving and growing, the members of the AdaptAlp Work Package "Water Regime" group (WP4) recommend a cyclical approach to planning any water-related activity or construction that is potentially affected by the local or regional climate. For the Alpine Space, this recommendation should be interpreted in the widest possible sense: The improvement and harmonisation of monitoring networks, the continued development of impact models to integrate all relevant processes, the combination of statistical and deterministic methods, the inclusion of new data and methods from the climate modelling community, a continuous and thorough assessment of local vulnerability to natural hazards with a view to the whole river system rather than isolated areas. All this can contribute significantly to the resilience of local communities faced with natural hazards, if the planning process takes up-to-date information into account.

Climate projections must not be over interpreted. It can be generally concluded that estimated changes in the mean are more robust than the changes in the extremes and that the 'model chains' used for impact modelling are less reliable for flood events than for average water balance simulations. Adaptation measures and strategies must take into account the uncertainty of the climate change estimates, including the possibility that the future climate could move outside today's estimated bandwidth.

Workpackage: Hazard Mapping

Coordinator: Florian Rudolf-Miklau (Federal Ministry of Agriculture, Forestry, Environment and Water Management, Austria)

Work Package Description

This work package evaluated, harmonised and improved different methods of hazard-zone planning currently at use in the Alpine region. Focus was made on a comparison of methods for mapping geological and water risks in the different Alpine countries. A glossary was created to facilitate transdisciplinary and translingual cooperation as well as to support the harmonisation of various methods. In selected model regions (Gasen-Haslau), methods to adapt risk analysis to the impact of climate change were tested. The research supported the development of hazard zone planning that includes a climate change adaptation strategy.

Summary of Results

As knowledge about the impact of climate change on the frequency and intensity of catastrophic events is still fragmentary, adaptation strategies on the European level should continue to be focused on the reduction of the vulnerability of society and infrastructure. Adaptation to climate change will be a long and continuous process. It will operate at all levels and require close coordination between stakeholders.

In practice, adaptation strategies have two contradictory aspects: Firstly, the general impact of climate change on the environment and on human activities (health, economy and cultural heritage) is beyond debate, although, as of today, the extent of impact on natural hazards can not yet be proven quantitatively; secondly, it is also beyond debate that the impact of the rapid increase of damage potentials due to human activities is of major significance to vulnerability levels. This leads to the conclusion that adaptation strategies concerning the hazard maps are urgent, with or without climate change.

Primary Recommendations

Looking upon the national adaptation strategies, a wide range of valuable measures and action can be identified that provide important links for the implementation of AdaptAlp WP5 results:

1. Furthering the improvement of hazard and risk maps with emphasis on cross-border and international harmonisation.
2. Fostering sustainable regional development with respect to hazard zoning.
3. Improving web-based information systems (free public access to hazard information).
4. Establishing of hazard zones in the law of regional development.
5. Keeping actual and future endangered spaces free (hazard mapping).
6. Adapting buildings and infrastructure in risk areas (construction standards).
7. Integrating scenarios into hazard assessment process.
8. Favouring the use of long-lasting data sets, as design values in small catchment areas are highly uncertain.
9. Performing research on the interaction of climate change and slope stability.
10. Raising public awareness for residual risks.

Workpackage: Risk Prevention & Management

Coordinator: Peter Greminger (Federal Office for Environment, Switzerland)

Work Package Description

The aim of this work package was to integrate risk management, particularly risk dialogue, into the decision making process in order to manage the challenging effects of climate change. The analyses and further development of existing methods and tools in all sectors of the risk cycle were performed and promoted as well as the cross-border dissemination of specialised knowledge through education and training of experts involved in risk management.

Summary of Results

To maintain and improve the current level of safety under changing framework conditions, the cornerstones are:

1. Further development and implementation of integrated risk management in research, education and practice.
2. Promotion of risk dialogue.
3. Consistent involvement of all relevant actors and the population in risk management at the right time and at the right level (strategic as well as operational benefits).
4. The current safety requirement is continuously changing due to an increase in damage potential, in the vulnerability of the endangered infrastructures, in the demand for safety, and in the effects of climate change on natural hazards. Climate change is just one element of the changing conditions in the context of risk management. Nevertheless, the continuous improvement of integrated risk management supports adaptation to climate change effects by invoking the correct measures and methods at the appropriate time.

Primary Recommendations

1. The most effective strategy to deal with the influence of climate change on natural hazard processes is the measured consideration of natural hazard processes in land-use planning, the reinforcement of personal responsibility for the protection of property and risk-appropriate priority-based investment in risk reduction measures such as early warning, prevention, emergency planning, etc. This necessitates the efficient coordination of the activities and measures carried out by all participating actors and the targeted introduction of a risk dialogue that enables joint and risk appropriate decision-making, even in uncertain data situations or an observed increase in risks due to climate change.
2. In accordance with the current state of knowledge, it is recommended to consider the effects of climate change to natural hazards only if they are reliable and significant. It is recommended to avoid the generalisation of some single effects of climatic changes to all natural hazards over all locations in the Alps. This requires the following actions:
   a. Development of a method for identification of climate-sensitive areas in which the effects of climate changes have significant negative influences on natural hazards.
   b. Installation of a monitoring system to observe the temporal evolution of natural risks in connection with climate data and the development of damage potential. These risk analyses of natural hazards should be repeated every 10-15 years. A periodic monitoring of the risks will allow the identification of situations in which the effects of climate change are significantly influencing the risks, resulting in the decrease of a targeted level of security. It will enable us to distinguish between increasing risks that are due to climatic changes, due to higher vulnerability, or due to inappropriate land-use.
   c. If the risk observation indicates that a significant increase of natural risks is occurring as a result of the effects of climate change, then these risks should be managed by following the holistic approach of integrated risk management.


Photo: TIWAG

Workpackage: Pilot Actions & Synthesis

Coordinator: Marion Damm (Bavarian State Ministry of the Environment and Public Health, Germany)

Work Package Description

This work package was geared towards the collection and organisation of all the knowledge acquired within the scope of the project, in order to make it accessible to local and regional decision-makers in the fields of civil protection and land-use planning. The strategies and methods developed in the previous working packages were tested and put into practice within the designated pilot regions.

Those activities aimed at identifying potential hazard zones and communicating possible dangers and risks. At the conclusion of the project, the knowledge acquired and results of the study were summarised and published.

Summary of Results

Altogether, it can be stated that implementation of adaption measures and the awareness of risks of a changing climate are still evolving. While first steps have been made, in the future it will be important to find a way not only to reach single municipalities or regions but to raise awareness in all municipalities in Alpine space that are prone to natural hazard risks. The municipalities require all available data regarding the risks they are currently facing or will face in the upcoming decades. Furthermore, some efforts are still required to identify the correct pathways of communication between administrations, stakeholders and the public. Additionally, the most appropriate incentives, not only financial support, need to be identified.

Primary Recommendations

From the experiences gained during the work in the pilot areas, the following recommendations can be derived to support a municipal development that is sustainable and ready for climate change:

1. It is crucial to pass on the experiences gained with natural hazards in a municipality to the next generations to maintain a certain level of consciousness within the community.
2. By combining technical protection measures with land-use restrictions or setting up flood retention areas, a high level of security can be created.
3. Spatial planning and decisions with regard to spatial development should always maintain a view towards the future, considering not only the changing environmental conditions, but also taking socio-economic and settlement development trend analyses into account.
4. Future spatial planning should recognise that compact settlement structures and less scattered settlements reduce the costs of protection measures.
5. Risk communication must start at a young age (risk education); this needs to be an essential component of disaster risk management in the municipalities. Regular events need to be organised that guarantee the involvement of authorities, experts, stakeholders and affected citizens.

Pilot Activities and Good Practices

Gasen and Haslau
A new way of dealing with geological hazards was tested during a revision of hazard zone maps in the municipalities of Gasen and Haslau. More detailed hazard maps and additional hazard analyses were developed and subsequently discussed with experts and local authorities. In this way, mid- and long-term problems could be addressed, in particular with regard to land-use planning.

Immenstadt
Based on the results of the Expert Hearing in November 2009, two case studies pertaining to flood events, bedload and debris flow surges were discussed within the scope of a practitioner's workshop held in Immenstadt in April 2010. The aim was to discuss recommendations for risk management over and above technical measures. New ideas were tabled for the improvement of risk dialogue and the handling of the residual risk.

Biber Berti
In Austria, Biber Berti has become a successful tool that teaches children about natural hazards though the use of cartoon characters, 'Berti' the beaver, and his friends, 'Stani' the mountain goat and the Cornish Chough, 'Kilian'. Together, they teach children the right way of dealing with natural hazards. AdaptAlp created a new homepage for Biber Berti and an additional climate change focus.

RiskPlan
RiskPlan is a calculation and management tool used to assess the risks posed by hazard processes in defined areas and to ascertain the cost-effectiveness of protective measures. For AdaptAlp, RiskPlan was tested in several pilot projects in Slovenia, Germany, Italy and France.

PlanAlp Database
This database product from the project ClimChAlp gives an overview of the various organisations or administrative structures responsible for risk management. The structure of the database is adapted to the different activities within integrated risk management, including prevention, early warning, event management, and restoration. AdaptAlp proposed comparison frames of the diverse alpine administrative systems identified in PLANALP database. This new presentation is user-friendly and helps to identify the differences and similarities between the various systems of the selected regions, which is a key point when comparing or harmonising public risk policies or strategies.

ON_ALP_EXCHANGE
The Internet platform 'on_alp_exchange' is an initiative of AdaptAlp that was designed to facilitate and increase the collaboration of experts dealing with natural hazard prevention throughout the Alpine area. The target group for this initiative includes practitioners and experts as well as administrative staff in the fields of flood protection, torrent and avalanche control, geology, risk prevention and disaster management. After registering on the site, participants can exchange ideas and gain insight into the similar work of other organisations.

Glossary of Geo-Hazards
In order to tackle the complexity and ambiguity encountered when defining and using landslide terms in scientific work, AdaptAlp created a multilingual glossary that provides users with a selection of official terms used by the geological agencies in a specific country, and gives their synonymous terms employed in other countries. A glossary table includes terms in English, German (Germany, Switzerland, Austria), French, Spanish (Catalan, Castellano), Slovenian and Italian.

Water Regime Impact Analyses
AdaptAlp analysed observed trends for different hydrological regimes and carried out impact analyses for river catchments in different climatic zones of the Alps, including the Inn River (north-east), the Alpine Rhine (north-west), the Upper Soča River (south-east) and the Adda River (south-west). Looking at climatic regions and hydrological units proved extremely useful in assessing climate-induced changes in the water regime of the topographically complex Alpine Space.

Photo: European Academy of Bolzano/Bozen

The AdaptAlp Project

Summary

AdaptAlp involved the collaboration of scientists and practitioners from six countries: Austria, France, Germany, Italy, Slovenia and Switzerland. The project addressed the question of how to adapt to the risks of natural hazards within the changing environment of the highly complex and sensitive Alpine region. The goals of the project were:

1. To improve information on the potential impact of climate change at the regional level using state-of the-art approaches (e.g. high resolution modelling).
2. To evaluate and harmonise different methods of risk assessment, hazard mapping and risk management in the Alpine environment.
3. To identify good practice methods and transfer best practice experiences into adaptation measures in model regions.
4. To reduce risk by raising awareness among local stakeholders.

Project Statistics

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European Territorial Cooperation
Alpine Space 2007-2013

Priority
Priority level 3 – Environment and Risk Prevention

Time Frame of the Project
01/09/2008 - 31/08/2011

Total Cost of the Project
€ 2,870,635

Partners

- Bavarian State Ministry of the Environment and Public Health (Germany)
- Bavarian Environment Agency (Germany)
- Federal Institute of Hydrology (Germany)
- Federal Ministry of Agriculture, Forestry, Environment and Water Management (Austria)
- Autonomous Province of Bozen/Bolzano, South Tyrol (Italy)
- Ministry for the Environment, Land and Sea (Italy)
- Geological Survey of Slovenia (Slovenia)
- CIPRA Germany (Germany)
- Regional Government of Carinthia (Austria)
- Office of Government of Tyrol (Austria)
- Piemonte Regional Agency for Environmental Protection (Italy)
- Aosta Valley Autonomous Region (Italy)
- Agricultural and Environmental Engineering (France)
- Grenoble Institute of Research and Study for Prevention of Natural Hazards (France)
- European Academy of Bozen/Bolzano (Italy)
- Federal Office for Environment (Switzerland)

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Photo: Thinkstock

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