CLISP - Climate Change Adaptation by Spatial Planning in the Alpine Space

WP 6 Risk Governance & Risk Communication

Guidance Paper for Risk Governance in Spatial Planning

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TABLE OF CONTENT

List of tables

List of figures

A Introduction

Intention

The project CLISP aimed at introducing climate change aspects to spatial planning and, especially within WP6, fostered an open dialogue between project participants and stakeholders in model regions. Based on embedding risk communication principles in project activities, WP6 contributed to raising awareness on climate-related risks by conducting dialogue processes with regional and local stakeholders. By assessing existing risk management systems, and by investigating the role of spatial planning in the management of climate-induced, spatially relevant risks in model regions, WP6 also aimed at exploring opportunities of employing risk governance principles in planning procedures and contributing to increased consideration of climate change issues in spatial planning.

Given the expected future increase in climate change induced risk potentials, there is a growing need to adapt to spatially relevant adverse climate change impacts in a preventive way. In this context, the role of spatial risk management in climate change adaptation is increasingly being called upon (BMVBS/BBSR, 2009). The assessment of existing risk management structures in a region may foster a more integrated approach to adaptation and may help to enhance the coordination of adaptation and mitigation approaches across all sectors concerned with climate change in the future. Since climate change adaptation is, up to now, not an own sectoral planning domain, and both climate change adaptation and spatial planning are by definition cross-cutting issues, cross-sectoral coordination is essential to climate-related risk management. Therefore adaption seems only promising and sustainable when tackled on an intersectoral basis. In CLISP, stakeholder participation in project activities, risk communication towards stakeholders, and investigation of existing risk governance structures in regard to spatial planning were central activities within WP6. The lessons learnt are integrated in this guidance document.

Risk Governance is a normative concept that is used in discussions about natural hazards, climate change, new emerging technologies as well as related social risks in recent years. Risk Governance is an emerging concept that covers the entire process of risk assessment, management and communication by integrating formal institutions and informal regimes, diverse and possibly conflicting assumptions and world-views as well as a multitude of stakeholders. (CapHazNet, 2011). One of the desired results of the Risk Governance approach is a better handling of risk management in the future. To reach this goal the abstract and complex concept of Risk Governance has to be adapted to regional structures and sector specific issues. In the last years the concept of governance has been applied to several policy fields. However, Climate Change Risk Governance is a fairly new concept, especially to spatial planning. Here, risk management is in practice often viewed as a task of specific sector planning domains, such as natural hazard management and flood protection, and knowledge of spatial planning bodies about risk management structures is often limited. There is a need for better risk management procedures that consider multiple sectors and levels of governance; these are also core principles of risk governance. In addition the communication of risk and participation of stakeholders in decision processes are thought to bring advantages when implementing new adaptation strategies. The management of climate-related risks is organized differently from country to country and often within a country, in particular in federal states with division of competences between the national and the state levels. The entire risk governance setting depends on scientific, natural, economic, social and cultural aspects. Additionally, the state of knowledge and awareness of people affected by climate change impacts in a region is usually inconsistent. Consequently, this guidance paper intends to present the knowledge and understanding of risk governance and risk communication based on the results of the project CLISP so that the recommendations can be applied on a transnational level. The potential role of spatial planning will be discussed and recommendations given. Incorporated are findings of the work in the CLISP model regions as well as theoretical recommendations as described in the literature.

Objectives

The overall topic of this guidance paper is climate change risk governance, including the potential role of spatial planning. However, spatial planning is only one player in the entire frame of risk governance and its potential role in supporting climate change adaption is still developing. Climate change is a cross-sectoral issue, and managing the specific risks (e.g. natural hazards or water management) may need different players in risk government structures. Consequently, one has to assess the risk situation on an all-encompassing basis and subsequently determine whether spatial planning could contribute to a more efficient and sustainable risk management procedure. The specific objectives of this risk governance guidance paper are the following:

1. **Giving an introduction to the state-of-the-art of risk governance concepts**, including risk communication;
2. **Giving an overview of good communication principles and emphasizing the need for communicating expected adverse climate change impacts and related risks and potential benefits**, which includes challenges of communicating climate change uncertainties, dealing with different individual risk perceptions and addressing the potentially reluctant attitude of the public and relevant stakeholders to adaptation;
3. **Indicating the relevance of risk governance and risk communication for climate change adaptation by spatial planning,** incorporating the lessons learnt in the CLISP model regions and theoretical aspects;
4. **Recommending management options on important aspects of risk governance,** including cross-sectoral coordination, multiple governance levels and communication (e.g. uncertainty) aspects;
5. **Introducing guidance for decision-support for the focus topic: Natural Hazards,** including the role of spatial planning.

The executive summary follows in **Part B**. The guidance paper has two main parts: **Part C** will introduce the reader to risk governance concepts and the potential role of risk governance and risk communication in spatial planning on a theoretical basis. In **Part D** the focus topic: natural hazards will be discussed in context with risk governance and the relevance to spatial planning. A decision supporting risk assessment tool will be introduced. This is followed by a conclusion in **Part E**.

B Executive Summary

The project CLISP aimed at introducing climate change aspects to spatial planning and, especially within WP6, fostered an open dialogue between project participants and stakeholders in model regions. By assessing existing risk management systems, and by investigating the role of spatial planning in the management of climate-induced, spatially relevant risks in model regions, WP6 also aimed at exploring opportunities of employing risk governance principles in planning procedures and contributing to increased consideration of climate change issues in spatial planning. After introducing the reader to risk governance concepts and the potential role of risk governance and risk communication in spatial planning **(Part C)** the focus topic: natural hazards is discussed in the context of risk governance, the relevance to spatial planning and guidance for decision support **(Part D)**.

Risk Governance - a widely used term in discussions about many kinds of risks like natural hazards, climate change, health and food safety - is a complex concept. Consequently, in the theoretical part of this guidance paper **(Part C)** a review of risk governance concepts and approaches is given. A conceptual risk governance framework comprises many domains (economic sectors, levels of governance) and “integrates scientific, economic, social and cultural aspects and includes the effective engagement of stakeholders" (Renn, 2005). The problem of interplay among institutions (lack of vertical and horizontal cooperation) often is a major reason for the ineffectiveness of management strategies and measures. The institutional vulnerability can thus be seen as one of the main aspects in dealing with risks because the whole disaster cycle from mitigation, preparedness, response to recovery is embedded in an institutional system. Risk governance aims at increasing the resilience of societies by – among others – a reduction of institutional vulnerability. For practitioners a normative approach like governance often seems too abstract and theoretical and the direct link to their daily work is often unseen (Fleischhauer et al, 2009). This guidance paper aims at enhancing the understanding of the role of climate change and spatial planning in the context of the complex system risk governance. In addition, the importance of good communication between domains is accentuated. Risk communication is an important part of risk governance, and often by establishing a good communication network the existing governance structures can be strengthened. It is recognized that in spatial planning the focus of response may differ from disaster management, however, a deeper understanding of the relationship between both domains may help to face the challenges caused by climate change.

In most of the CLISP model regions natural hazards were identified as of concern in regard to climate change and therefore are handled as a focus topic **(Part D)**. The transition from mitigation to adaptation is in most countries seen as an important task, but the potential role of spatial planning is not apparent yet. In order to consider climate change risks in the coordination of natural hazard management with spatial planning several aspects have to be considered. First there has to be an impact assessment of climate change on natural hazards (magnitude, frequency) and inherent uncertainties. Aspects of governance and communication include intersectoral coordination, different levels of governance and communication to/participation of stakeholders and the public. The wider the audience and the understanding of the benefits and limitations of participation the acceptance will rise and the willingness to participate will increase.

When dealing with climate change, uncertainties are inherent to the predictions and subsequently bias the impact assessment of natural hazard activity (magnitude and frequency). Irrespective of these limitations decisions have to be made in spatial development. The question is on how risk governance concepts can be applied to better manage natural hazards in an uncertain future. Generally it has to be said that uncertainties of alpine natural hazards outweigh the influence of climate change aspects.

In CLISP all model regions identified intersectoral coordination as a major contributor to successful governance of climate change risks. In the last years the need for well structured risk governance processes in managing intersectoral problems has been promoted and participation named as an integral part of any risk management procedure. Apart from the intersectoral dependencies spatial planning involves different levels of governance and stakeholders of various interest groups. Apart from the mentioned participation in intersectoral problem solving communication is seen as a very important aspect in all phases of the decision process from the problem framing to the successful implementation.

In **Section 2** of the thematic focus existing risk management procedures and limitations regarding climate change are described on transnational level and recommendations are given on how to deal with upcoming challenges. Based on existing legal frameworks and spatial planning instruments the question is how to deal with climate change in natural hazard management. In the last years this issue was widely discussed by natural hazard as well as spatial planning experts. In the CLISP project most of the spatial planners identified integration of climate change risks in instruments of natural hazard management as a task of relevant sectoral policies at the national level. In that perspective, methods and instruments of hazard management that take account of climate change risks have to be provided as a planning basis before they can be implemented by spatial planning and on lower levels of governance. Instead of a new structuring of the governance system, the enhancement of existing planning instruments was rather favoured.

The requirements in natural hazard risk management procedures are becoming higher due to climate change. In view of the heterogeneity of stakeholders, levels of governance and sectoral cooperation in modern risk governance frameworks static planning instruments do not appear feasible anymore. More dynamic planning procedures, also incorporating regional development strategies, seem more promising to meet the challenges and uncertainties of climate change. In order to facilitate an easy implementation of new approaches in existing structures decision tools are indispensable. In **Section 3** of the thematic focus a decision-supporting guidance is introduced that intends to assist the decision maker in different parts of the decision process. The concept aims at the identification of climate change impacts on natural hazard processes, i.e. an estimation of the sensitivity of hazards processes to changes in climatic stimuli. The $CC_{mountain}$Fitness Guidance tool will give guidance on how to analyze the status quo of natural hazard processes within a region, their sensitivity to climate change, and the related uncertainties. The main user groups of the tool are natural hazard experts (mainly public authorities), whereas the results will be important for all spatial planning decision makers, like mayors or planners at the municipality level. The $CC_{mountain}$Fitness Guidance complements the results of CLISP WP5 in the regard that its intention is rather on the local implementation than on specific spatial planning instruments. In contrast to the vulnerability analysis in WP4, which focuses on regional vulnerabilities, here the focus is on process level.

In addition to the decision-support concept presented in this guidance paper, a communication and decision support tool (CDT) has been developed and tested in an Austrian pilot municipality. An evaluation and discussion of test results is compiled in the WP6 Synthesis Report (www.clisp.eu).

Altogether the guidance paper comprises a theoretical overview of the risk concept and a more practical application in natural hazard management, including the potential role of spatial planning.

C Risk Governance – Concepts and Theoretical Background

1 Introduction to Risk Governance

1.1 Definitions

The following definitions of key terms are applied in this paper:

Adverse consequences: The occurrence of a hazard may lead to damage or harm to human health, the natural environment or material assets of the built environment. The possibility of an adverse outcome is essential to the concept of risk. The magnitude or severity of adverse consequences depends, amongst others, on the characteristics of the hazard and on the sensitivity of the receiving environment towards the impacts of a hazard, i.e. on the vulnerability of receptors.

Exposure: The nature and degree to which a system is exposed to significant climatic variations (IPCC, 2001), or to some other hazard.

Governance: The actions, processes, traditions and institutions by which authority is exercised and decisions are taken and implemented. "Governance is the process by which stakeholders articulate their interests, their input is absorbed, decisions are taken and implemented, and decision makers are held accountable" (Furlong and Bakker, 2008). Government, on the other hand, is the institutional design and structure that operationalizes governance principles (Plumptre and Graham, 1999).

Good governance: A concept that includes a set of principles and a collection of methods that appear in slight variations in recommendations and policies of e.g. the UNDP, the European Commission and the World Bank. "Good governance is, among other things, participatory, transparent and accountable. It is also effective and equitable. And it promotes the rule of law" (UNDP, 1997).

Hazard: A property, an event or a situation with the potential to cause harm. A hazard can be a chemical, biological or physical agent, or a threatening event, or characteristics of a system that represent the potential for an accident. A hazard is a source of risk that does not mean risk per se and that does not necessarily produce risk. It produces risk only if an exposure pathway exists and if exposure creates the possibility of adverse consequences (Royal Society, 1992; Brookes, 2001; Kolluru, 1996; DEFRA, 2000). A source of potential harm or a situation with the potential to cause loss (Renn, 2005).

Risk: An uncertain consequence of an event or an activity with respect to something that humans value. Such consequences can be positive or negative, depending on the values that people associate with them (Renn, 2005).

Risk communication: Interactive process of exchange of information and opinion among individuals, groups and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about risk, that express concerns, opinions or reactions to risk messages or to legal and institutional arrangements for risk management (Renn, 2008 after: US National Research Council, 1989)

Risk governance: For the International Risk Governance Council (IRGC), risk governance is defined as: "the application of the principles of good governance to the identification, assessment, management and communication of risk" (IRGC, 2011).

Following Renn (2008), Risk Governance includes the totality of actors, rules, conventions, processes and mechanisms concerned with how relevant risk information is collected, analysed and communicated, and management decisions are taken. Encompassing the combined risk-relevant decisions and actions of both governmental and private actors, risk governance is of particular importance in (but not restricted to) situations where there is no single authority to take a binding risk management decision, but where, instead, the nature of the risk requires cooperation and coordination between a range of different stakeholders. Risk governance, however, not only includes a multifaceted, multi-actor risk process, but also calls for the consideration of contextual factors, such as institutional arrangements (e.g. the regulatory and legal framework that determines the relationship, roles and responsibilities of the actors, and coordination mechanisms such as markets, incentives or self-imposed norms) and political culture, including different perceptions of risk.

Risk management: The creation and evaluation of options for initiating or changing human activities or (natural and artificial) structures with the objective of increasing the net benefit to human society and preventing harm to humans and what they value; and the implementation of chosen options and the monitoring of their effectiveness (Renn, 2005).

Stakeholder: A person or an organisation that has a legitimate interest in a project or entity, or would be affected by a particular action or policy (IPCC, 2007; WG II). Stakeholders can be grouped into institutional stakeholders: Those (organised) groups that represent specific interests ("stakes"). These can be (a) formal decision-makers that are involved in risk management and that have official tasks ("administrative" or "decision-making" stakeholders) and (b) those that influence decisions more indirectly (interest groups, NGOs etc.). The institutional stakeholders have to be distinguished from other stakeholders such as the public/local citizens (Fleischhauer et al., 2009)

Stakeholder analysis: The identification of key stakeholders, an assessment of their interests, and the ways in which those interests affect project riskiness and viability. It contributes to project design by identifying the goals and roles of different groups, and by helping to formulate appropriate forms of engagement with these groups (Allen and Kilvington, n.d.).

Stakeholder participation: Bringing together stakeholders; supporting and challenging all stakeholders to be actively engaged (Hemmati, 2002). Organised forums of exchange for society and government interactions. On the basis of the ladder of citizen participation proposed by Arnstein (1969) we can distinguish between a) participation by information; b) participation by consultation; c) participation based on the model of partnership (codetermination); and d) the control of decision-making by citizens (determination).

Uncertainty: Uncertainty is inherent to the concept of risk. Risk involves thinking in potentialities. It implies that neither what exactly will happen nor when it will happen, nor what and how severe the effects exactly will be is known. If the outcome of something is certain, we do not speak of risk (Crawford-Brown, 1999). That is why risk is expressed using properties like probability, frequency, and variability. In probabilistic terms, risk is a probability distribution within a range of different possible outcomes. Above all, uncertainty over the future is the main reason why risk assessment is needed.

1.2 Scope of risk governance

Risk Governance - a widely used term in discussions about many kinds of risks like natural hazards, climate change, health and food safety risks - is a complex concept. Due to the fact that there are a lot of Risk Governance definitions the paper does not aim to focus on an additional definition but to focus on the principles of (good) governance to make the concept applicable for practitioners. Additionally to the complexity of risk governance an analysis of existing governance processes is complicated by the fact that risk governance structures on different spatial scales are sometimes not existing (because governance as a concept is still new) or tacit knowledge.

Risk governance dealing with climate change issues gains an additional complexity: Decisions in the area of so called "traditional" risks like flooding are normally based on probabilities because they are past-oriented and informed by statistics. Climate change related effects on temperature and precipitation, however, will certainly lead to new uncertainties, because past events might be not representative anymore (Fleischauer et al., 2009).

A conceptual risk governance framework comprises many domains (economic sectors, levels of governance) and "integrates scientific, economic, social and cultural aspects and includes the effective engagement of stakeholders" (Renn, 2005). The problem of interplay among institutions (lack of vertical and horizontal cooperation) often is a major reason for the ineffectiveness of management strategies and measures. The institutional vulnerability can thus be seen as one of the main aspects in dealing with risks because the whole disaster cycle from mitigation, preparedness, response to recovery is embedded in an institutional system. Risk governance aims at increasing the resilience of societies by – among others – a reduction of institutional vulnerability. For practioners a normative approach like governance often seems too abstract and theoretical and the direct link to their daily work is often unseen (Fleischhauer et al., 2009). This is why the concept will be explained here in order to enhance the understanding of the role of climate change and spatial planning in the context of the complex system risk governance. In addition, the importance of good communication between domains will be accentuated. Risk communication is an important part of risk governance and often by establishing a good communication network the existing governance structures can be strengthened. It is recognized that in spatial planning the focus of response may differ from disaster management, however a deeper understanding of the relationship between both domains may help to face the challenges caused by climate change.

Today's risk management practice is often characterised by distrust in public decision-making due to a lack of inclusiveness. Both, mandatory public decisions and individual measures, to be taken by single households and individuals, need to be understood and accepted for implementation. The given distrust makes communities, and in particular institutional settings like spatial planning administration, less adaptive and more vulnerable. Vulnerable communities cannot be resilient. In consequence, risk governance can also be seen as procedural path towards the material goal of resilience (Greiving, 2009).

One main purpose of stakeholder involvement is to build mutual trust by considering concerns of the public and relevant stakeholders. Over the past years several studies on climate change and associated risks have outlined the necessity for an integrated risk management procedure (e.g. ClimChAlp, 2008). However, most of the suggested strategies dealt with short-term risk issues, such as the mitigation of catastrophic events (e.g. response to flooding). Long-term sustainability, as matters in spatial planning, was often neglected. Not long ago, many planners and decision makers felt that the scientific knowledge about future climate was too uncertain to have the confidence to act on (Lee, 2001). Now it is increasingly being accepted that spatial planners must act despite the presence of uncertain future conditions of climate change and the associated risks. In the project ClimChAlp (ClimChAlp Partnership, 2008: Common Strategic Paper) it was recognized that one of the key needs for actions in the field of spatial planning was to avoid and reduce climate-related risk potentials by strengthening risk-oriented, integrated spatial planning, including via initiating a "risk dialogue" between administration and the public, and by informing inhabitants and land owners about on-site risks and the individual responsibility for risk precaution. Truly integrated spatial planning should also include a basic coordination of adaptation and mitigation approaches (which is not only required for spatial planning, but for all sectors concerned with climate change). This underlines the importance of risk governance and its coordination across sectors.

It is a challenging task to introduce climate change related issues to spatial planning in different domains (economic sectors, levels of governance), also because of existing uncertainties. What is known and what is still unknown should be effectively communicated to the public and relevant stakeholders so that the uncertainties can be accounted for in the decision process.

2 Review of risk governance concepts and approaches

2.1 Risk, risk assessment and risk management

2.1.1 The concept of risk

Despite divergences in definitions, most classical definitions of "risk" have several key elements in common. Most definitions include at least three main elements (Covello & Merkhofer, 1993; Gazso, 2005):

- the possibility of an adverse outcome (damage, harm, loss);
- the probability that an adverse outcome will occur, which can also be described as uncertainty over the occurrence, timing, and magnitude of those adverse consequences; and
- a functional linkage between probability of occurrence and magnitude of adverse consequences.

More detailed, risk is a complex concept that usually comprises a number of distinct components. As risk assessment has gradually shifted from hazard-based to risk-based approaches during the last decades (Fairman et al., 1999), most modern definitions of risk put much emphasis on the clear distinction of hazards, adverse consequences, and risk as such, as well as on the linkages between these elements.

According to most definitions in an environmental context, the existence of risk requires the presence of the following components: Hazard, exposure, adverse consequences, connectivity and uncertainty (see Section C 1.1: Definitions).

There is no single definition of risk that encompasses the whole functional system of hazards, likelihood, exposure, consequences, vulnerability and associated socio-cultural aspects. However, most definitions have in common that risk is usually characterised as a qualitative description or a quantitative measure which represents a function of the probability of occurrence of a defined hazard and the magnitude of the adverse consequences of the occurrence within a certain range of possible outcomes. Risk is usually considered within a certain time frame.

2.1.2 Risk Assessment

In general terms, risk assessment comprises the scientific methods of confronting and expressing uncertainty in predicting the future (ADB, 1997). Regardless of differences in schools and approaches, it can be defined as a systematic process for describing and/or quantifying the risk associated with some substance, situation or action by gathering, structuring, and analyzing available information on hazards, exposure, and consequences. The European Environment Agency (EEA) defines risk assessment as a procedure in which the risks posed by inherent hazards involved in processes or situations are estimated either quantitatively or qualitatively (Fairman et al., 1999). The key tasks of any risk assessment process are to estimate the probability of occurrence of a hazard and the probable magnitude of adverse effects – including safety, health, ecological or financial effects – over a specified time period (Kolluru, 1996).

The term 'risk analysis' is often used synonymously to 'risk assessment', but sometimes it is used in a broader meaning that also encompasses aspects of risk management (Kolluru, 1996).

Uncertainty is an inherent and unavoidable aspect of risk assessment. The advantage of a systematic risk assessment, compared to mere straight-forward impact predictions, is that it can and should make uncertainty explicit (Brookes, 2001). Uncertainty is usually expressed and quantified by using the well-established methods of probability theory. Thus, a quantitative risk assessment typically generates a probability distribution for a range of possible consequences of different magnitudes, including further measures for uncertainty of risk estimates, such as confidence intervals etc. (Covello & Merkhofer, 1993; Kolluru, 1996).

Basically, risk assessment addresses the following questions (Fairman et al., 1999):

- What can go wrong to cause adverse consequences?
- What is the probability or frequency of occurrence of adverse consequences?
- What are the range and distribution of the severity of adverse consequences?
- What can be done, at what cost, to manage and reduce unacceptable risks and damage?

2.1.3 Risk Management

The main reason for wanting to assess and specify risks is to provide a sound information basis so that they can be prevented, reduced, managed or eliminated (Calow, 1998). In the end, risk assessment is about decision-making, and about taking actions under uncertainty (SRU, 1999).

Risk management can be defined as the process of developing and evaluating alternative risk management options and of selecting and implementing the most appropriate options. The information generated by risk assessment provides a systematic framework for identifying the most significant risks as well as time-sensitive, action-sensitive and investment-sensitive risks. It facilitates prioritizing risks and designing effective risk reduction and control measures, whereby an optimal resource allocation can be accomplished which aims at achieving the greatest reduction of the most unacceptable risks in the most cost-efficient way (Kolluru, 1996). Thus, the threat of directing huge funds at minor risks with low effectiveness in terms of risk reduction shall be avoided (Brookes, 2001; Sunstein, 2002).

Dating back to recommendations made by the US National Research Council in its landmark report "Risk Assessment in the Federal Government: managing the process" (NAS-NRC, 1983), a tendency has developed to keep risk assessment separate from risk management. This view is based on the rationale that risk assessment should be based on scientific criteria to the extent possible, whereas risk management usually involves political, social, economic, and technological issues as well. According to this paradigm, science should be isolated from socio-political considerations to avoid prejudgment of assessment results by cost implications and value judgments (Calow, 1998; Kolluru, 1996; Bartell, 1996; Wentsel, 1998). However, experience has shown that both the assessment and management phase often suffer from this disjunction (Kolluru, 1996). In practice, risk assessors often need input from risk managers to adequately define the assessment problem, risk management options may need re-assessment to determine whether it reduces the risks to an acceptable level, and each option may introduce new risks (Calow, 1998; DEFRA, 2000). Thus, there is a need to iterate between assessment steps and management (Brookes, 2001).

2.1.4 Risk Assessment and Management Process

Following the unified model of risk assessment developed by Covello & Merkhofer (1993), as adapted and modified by Fairman & Mead (1996; 1999), and including risk management, an (Environmental) Risk Assessment is composed of the steps listed below (Figure 1).

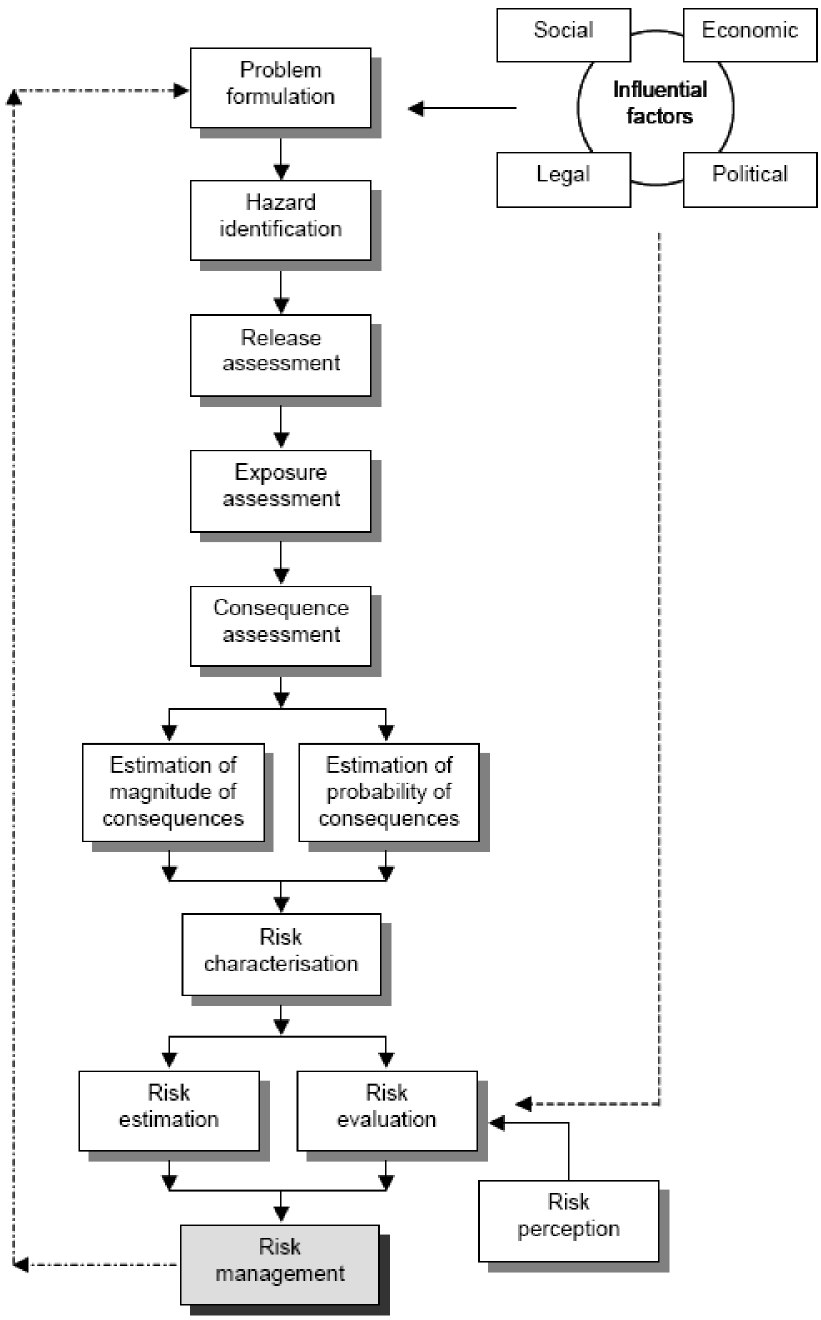

Figure 1. A model of environmental risk assessment (based on Fairman et al., 1999)

These steps are usually closely interrelated and may often be part of an iterative process, rather than distinctly separate steps. Depending on the situation, not all steps may be required in each application.

1. Problem formulation
2. Hazard identification
3. Release assessment
4. Exposure assessment
5. Consequence assessment
6. Risk characterisation
   6.1 Risk estimation

6.2 Risk evaluation

7. Risk management

2.2 Governance, good governance and risk governance

2.2.1 Introduction to the concept of governance

In CLISP the concepts of good governance and of risk governance were applied to the spatial management of climate change induced risks. The principles and standards of good (risk) governance offered a reference frame that was used as a benchmark to a) analyse and assess the performance of existing risk management processes, and b) to evaluate the performance of stakeholder dialogue in the model regions.

2.2.2 Governance

Governance refers to the actions, processes, traditions and institutions by which authority is exercised and decisions are taken and implemented. Government, on the other hand, is the institutional design and structure that operationalizes governance principles (Plumptre and Graham, 1999).

Because the concept of **governance** is used in several contexts, e.g. international governance, natural resource governance, financial governance and risk governance to name a few, there are many definitions for governance in the literature. The best definition with regard to the project CLISP is given by Furlong and Bakker (2008) in the context of water conservation, who stated that "governance is the process by which stakeholders articulate their interests, their input is absorbed, decisions are taken and implemented, and decision-makers are held accountable."

2.2.3 Good Governance

Good governance is both a method and objective of governance that can build up a basis for sustainable outcomes (Furlong and Bakker, 2008). The good governance concepts in the overview below are based on a literature review of governance; the validity in the context of risk governance will be addressed in the next section. The concepts were the basis for the analysis of existing risk governance systems and of the stakeholder interactions in the CLISP model regions.

Good governance is a concept that includes a set of principles and a collection of methods that appear in slight variations in recommendations and policies of e.g. the UNDP, the European Commission and the World Bank. "Good governance is, among other things, participatory, transparent and accountable. It is also effective and equitable. And it promotes the rule of law" (UNDP, 1997). Common to many reviews is that good governance includes elements of stakeholder inclusion, strategic thinking, accountability and fairness (Allen, n.d.).

Amongst other elements, the concept of good governance strongly relates to principles of **procedural justice** and **procedural fairness**, which are often promoted assuming that people would be more willing to accept decisions, even if they might entail disadvantages for them, if they consider a procedure (or the rules for the procedure) as fair and just (Ohl et al., 2008). Procedural justice and procedural fairness were and are still seen as means to strengthen legitimacy; essential subjective criteria for fair procedures and fair interactions are: voice, trustworthiness, respect, and truthfulness (Tyler 2000).

In the following major principles of good governance and of procedural fairness in governance are described according to the literature (Ohl et al., 2008; Furlong and Bakker, 2008; Kaufmann et al., 1999; UNDP, 1997; European Commission, 2001; Edgar et al., 2006; Liou, 2007):

Participation: In good governance, the principle to "hear the other side" emerged into the principle of participation, into the possibility to be not only heard but to have a voice in the decision-making process. The European Commission, for example, emphasizes that quality, relevance and effectiveness of EU policies depend on ensuring wide participation throughout the policy chain – from conception to implementation (European Commission, 2001). The OECD adds that broad participation is built on freedom of association and speech, as well as capacities to participate constructively (UNDP, 1997). The need for participation is found in the principle "voice and accountability" of the World Bank (Kaufmann et al., 1999).

Transparency: The free flow of information is another principle that also concerns the procedural process. Processes, institutions and information are to be directly accessible to those concerned with them, and enough information is to be provided to understand and monitor the processes (OECD) (UNDP, 1997). From the point of view of third parties it should be documented how stakeholders were selected to participate, and how their views were taken into account. From the point of view of the participants all process steps, communicative procedures, methods of reaching agreements and the future use of the produced results should be fully understandable (Renn, 2008).

Accountability: Decision-makers in government, the private sector and civil society are accountable to the public, as well as to institutional stakeholders (OECD) (UNDP, 1997). The European Commission summarizes within accountability that the roles in the legislative and executive processes need to be clear (European Commission, 2001). Consequently there should be a clear understanding of responsibilities in decision-making, implementation, monitoring and evaluation of processes.

Rule of Law: Legal frameworks should be fair and enforced impartially, particularly the laws on human rights (OECD) (UNDP, 1997). Indicators for the rule of law are in particular the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence (World Bank) (Kaufmann et al., 1999).

Equity: All men and women have opportunities to improve or maintain their well being (OECD). Together with the principle "rule of law", equity is summarised within "fairness" by the Canadian Institute on Governance (Edgar et al., 2006). According to Hemmati (2002) equity means levelling the playing-field between all relevant stakeholder groups by creating dialogue (and consensus-building) based on equally valued contributions from all and providing for all views to be represented, thus increasing the legitimacy and credibility of a participatory process.

Inclusiveness: Providing for all views to be represented, thus increasing the legitimacy and credibility of a participatory process (Hemmati, 2002).

Fairness: Procedural fairness implies that it is not the result (the outcome) of decision making that is in the centre of interest, but the process and the social togetherness in a pre-stage of decision making – the reason why procedural fairness is also termed as non-outcome fairness (e.g. Anand 2001). Procedural justice and procedural fairness were and are still seen as means to strengthen legitimacy; essential subjective criteria for fair procedures and fair interactions are: voice, trustworthiness, respect, truthfulness (Tyler 2000). Fairness includes also an adequate representation of the constituencies in the participatory process and in terms of equal speaking and debating opportunities among the participants (Renn, 2008).

Other good governance principles are: responsiveness (institutions and processes try to serve all stakeholders within a reasonable timeframe), consensus orientation, as well as effectiveness and efficiency in carrying out key functions.

2.2.4 Risk Governance

What is risk governance?

Referring to the field of water conservation, Furlong and Bakker (2008) state that governance issues are generally overlooked in favour of a purely technical approach, and improvement of governance has been identified to be central to success. This is likely to be the same for many other issues and should be considered also in climate change adaptation.

Risk Governance includes, but also extends beyond, the three conventionally recognized elements of risk analysis (risk assessment, risk management and risk communication). It requires consideration of the legal, institutional, social and economic contexts in which a risk is evaluated and involvement of the actors and stakeholders who represent them (Renn, 2008). Consequently, different perceptions of risk have to be dealt with. After Renn (2008) risk governance includes the totality of actors, rules, conventions, processes and mechanisms concerned with how relevant risk information is collected, analysed and communicated, and management decisions are taken.

Encompassing the combined risk-relevant decisions and actions of both governmental and private actors, risk governance is of particular importance in (but not restricted to) situations where there is no single authority to take a binding risk management decision, but where, instead, the nature of the risk requires cooperation and coordination between a range of different stakeholders. Risk governance, however, not only includes a multifaceted, multi-actor risk process, but also calls for the consideration of contextual factors, such as institutional arrangements (e.g. the regulatory and legal framework that determines the relationship, roles and responsibilities of the actors, and coordination mechanisms such as markets, incentives or self-imposed norms) and political culture, including different perceptions of risk.

Risk governance applies the principles of **good governance** to the identification, assessment, management and communication of risks. Thus, it incorporates such criteria as accountability, participation, equity, effectiveness, coherence and transparency (according to the White Paper of the European Commission on Governance) to the context of risk and risk-related decision-making (Gunningham et al., 1998) within the procedures and structures by which risk-related decisions are made and implemented. ***Risk governance is both a concept and a tool*** (Greiving, 2009). It addresses questions such as the understanding of the secondary impacts of a risk and of how it is managed, the development of resilience and the capacity of organisations and people to face unavoidable risks, the empowerment of those responsible for making and implementing decisions, the role of science and technology in policy making, the extent to which a precautionary approach should be used to address uncertainty and ambiguity and the balancing of an inclusive approach to decision making with the need to reach a decision (Renn, 2005).

"Good risk governance rests upon a combination of best available interdisciplinary knowledge, including the awareness of its limitations and uncertainties, and a careful synthesis of public concerns, values and visions" (Renn, 2008). Therefore the good governance principles (Section C 2.2.3) were used to analyse the existing risk governance structure in the model regions in regard to the adaptation to climate change by spatial planning (see Synthesis Report WP6).

What does a risk governance framework comprise?

Besides the standard elements of risk handling – risk assessment, management and communication – the IRGC (International Risk Governance Council) Risk Governance framework incorporates additional activities which reflect the need to ***deal with risk in a way that fully accounts for the societal context of both the risk and the decision that is reached*** *(Figure 2)*.

Figure 2. Risk governance framework (Renn, 2005)

The risk governance framework of the IRGC is split into an „Understanding" and „Deciding" side. The understanding of the risk is crucial for a sustainable decision. Communication plays a central role in the framework and emphasizes the need for a participatory approach.

The five main parts of the framework can be summarized as follows:

- Risk pre-assessment, early warning and "framing" the risk in order to provide a structured definition of the problem, of how it is framed by different stakeholders, and of how it may best be handled
- Risk appraisal, combining a scientific risk assessment (of the hazard and its probability) with a systematic concern assessment (of public concerns and perceptions) to provide the knowledge base for subsequent decisions

- Characterisation and evaluation, in which the scientific data and a thorough understanding of societal values affected by the risk are used to evaluate the risk as acceptable, tolerable (requiring mitigation), or intolerable (unacceptable)
- Risk management, the actions and remedies needed to avoid, reduce, transfer or retain the risk
- Risk communication: how stakeholders and civil society understand the risk and participate in the risk governance process

The framework offers an interdisciplinary and multi-level governance approach. Importantly, it urges risk governance institutions to gather and base their problem framing, evaluations and final decisions not only on knowledge about the physical impacts of technologies, natural events or human activities but also **knowledge about the concerns that people associate with these and other causes of risks.**

2.2.5 The Role of Risk Governance in the Risk Assessment and Management Process

How does risk governance relate to risk assessment and risk management?

The “classical” instruments of natural hazard risk management procedures are at their limit where the civil society actively requests the participation in decision processes (Rudolf-Miklau, 2009). This statement likely applies to other climate change induced risks. According to Rudolf-Miklau (2009) risk governance is an alternative for governmental actions, especially where a variety of stakeholders are involved in the decision-making process, a high degree of coordination is needed and the acceptance of compromises is required in order to guarantee a collective decision. He also points out the opportunity of balancing risks by saying that it is not always given that the stakeholders at risk are the same who benefit from protection measures. As an example, he mentions that, e.g. a municipality is paying for flood protection measures in their area and another municipality may profit from the flood retention measures without paying. He believes that by using a risk governance approach the beneficiaries could be convinced to also pay their part.

In the light of more recent contributions from psychological and social sciences, and responding to the growing need for stakeholder involvement, 'classical' definitions of risk assessment like the ones outlined in Section C 2.1 may be viewed as rather one-dimensional technical concepts. During the last few decades, gradually a new and wider risk-based paradigm has emerged that encompasses also psychological, sociological and cultural dimensions of risk (Gazso, 2001), and that puts stronger emphasis on 'soft' issues like risk perceptions, risk communication, and societal and cultural values.

Risk assessment is, of course, not the only basis for risk management. Risk assessment is a decision-supporting instrument, but it is no substitute for decision-making. It can provide estimates of risk, but it cannot answer questions like "how safe is safe?" and "how clean is clean?". Deciding on acceptability, or tolerability, of risks is the domain of risk management. Thus, decision-making on risk management also involves considering issues like societal values, public perceptions and preferences, costs and benefits, and technical feasibility, as well as their balancing, ranking and weighting, and often difficult trade-offs between them (Kolluru, 1996; DEFRA, 2000). As climate change induced risks affect multiple stakeholders and multiple sectors at different scales (local, regional) a participatory approach, as promoted in risk governance concepts, is necessary to reach a satisfactory and sustainable solution. By putting all arguments on the screen, evaluation of risk management options in close collaboration with the stakeholders affected, enables correction of cognitive limitations, such as overreacting to risks of high salience but very low probability by devoting large amounts of resources to them, and neglecting substantial risks that receive less public attention (Sunstein, 2002).

Referring to the typical steps of a risk assessment cycle as shown in Fig. 1, participation of stakeholders, people affected and decision-makers is most strongly required in the problem formulation, the risk evaluation and the risk management stage, while in other stages, though mostly technical expert tasks, an information exchange should at least be encouraged in risk governance.

In the end, the management of risks is always about decision-making and taking actions under uncertainty (SRU, 1999). The expected increase in future risk potential due to climate change is a reason why risk-related decision-making will become much more important in spatial planning in the future. On the contrary, static orientation on the 'worst case' scenario (e.g. by applying generous safety margins to potential future flood risk areas and keeping them totally free of land development) is often not feasible in spatial planning, which aims at balancing different interests in the use of space; aiming at avoidance of risk is very often synonymous with losses of opportunities for development (Lexer et al., 2008). Compared to that, risk-based decision-making emphasises the tolerability of risks and balances the expected benefits of risk reduction measures with their costs, which often requires difficult trade-offs. The final aim is to come to solutions that achieve the greatest reduction of the most unacceptable risks in the most cost-efficient way (Brookes, 2001; Sunstein, 2002), and to decide upon what risks are acceptable if weighted against the benefits of taking those risks. With regard to the long-term changes of climatic conditions, the solutions need to be sustainable and understood by stakeholders and the public. Here again risk governance approaches might help to establish a participatory environment.

Ratings of vulnerabilities, risk estimations and risk management decisions strongly depend on individual and societal values, perceptions and preferences. Experts, practitioners and the people affected by hazards usually have different perceptions of risk and vulnerability (DEFRA, 2000; Kolluru, 1996). There is increasing awareness that the value that is attached to the goods to be protected and issues of tolerability and acceptability of risk cannot – and should not - be decided upon in a 'top-down' way by experts or authorities alone, in particular in view of the absence of concrete rules or thresholds. Risk Governance emphasizes the need for participatory and inclusive approaches to handling of risks by combining bottom-up with top-down processes. This need applies particularly to risk issues that are complex, involve high uncertainty and/or pose situations of social dilemma (Renn, 2005). Here, mainly consensus is required to legitimate public decisions, which could, e.g., lead to restrictions for individual property rights.

Summing up, risk governance goes beyond "traditional" risk assessment and management because it puts much stronger emphasis on, inter alia, the following elements:

- Participation of stakeholders and civil society in risk identification, evaluation, communication and management
- Managing interdependencies (between multiple sectors, levels of governance)
- Applying the principles of good governance to handle risks
- Accentuating risk communication
- Strong consideration of different risk perceptions, values, preferences, and cultural settings

2.3 Risk Communication

2.3.1. Risk Communication: relevance and challenges

Hemmati (2002) defines **communication in a multi-stakeholder process** as the exchange of views (opinions) amongst stakeholders. It includes the expression of views in combination with the understanding of views to the point that there is mutual understanding. Communication can and should also include forms of information and dialogue with the broad public.

The risk governance framework is most distinctive in the centrality it gives to risk communication across and between all stages. The main emphasis of the framework is to see hazard assessment and risk management as acts of communication rather than a series of behavioural actions. Communication is understood to encompass many forms and purposes of flow of information between the different actors involved in risk governance and to include different modes of interaction, participation and partnership rather than only flows of ‘expert to non-expert’ information (Walker, 2010).

Why is risk communication so important?

Renn (2008) cites the OECD (2002) to express the ultimate goal of risk communication as “to assist stakeholders in understanding the rationale of risk assessment results and risk management decisions, and to help them arrive at a balanced judgment that reflects the factual evidence about the matter at hand in relation to their own interests and values”. Even though risk communication is important at any point in the risk governance framework one has to consider that over the duration of the project the choice of appropriate communication instruments has to be adapted to the needs of the stakeholders involved in a specific phase of the decision process (e.g. design, implementation, monitoring).

Not only institutional stakeholders, also the broad public needs to be included in risk communication activities. Factors that influence social vulnerability are lack of access to resources (including information, knowledge and technology) limited access to political power and representation; social capital, including social networks and connections; beliefs and customs; building stock and age; frail and physically limited individuals; and type and density of infrastructure and lifelines (Cutter et al., 2003).

Renn (2008) summarizes four major functions of risk communication as outlined by various analysts:

1. ***Education and enlightenment:*** inform the audience about risks and the handling of these risks, including risk and concern assessment and management.
2. ***Risk training and inducement of behavioural changes:*** help people to cope with risks and potential disasters.
3. ***Creation of confidence in institutions responsible for the assessment and management of risk:*** give people the assurance that the existing risk governance structures are capable of handling risks in an effective, efficient, fair and acceptable manner (such credibility is crucial in situations where there is a lack of personal experience and people depend upon neutral and disinterested information). It should be kept in mind, however, that trust cannot be produced or generated, but only accumulated by performance, and that it can be undermined by the lack of respect for people with critical views about the institution.
4. ***Involvement in risk-related decisions and conflict resolution:*** give stakeholders and representatives of the public the opportunity to participate in the risk appraisal and management efforts and/or be included in the resolution of conflicts about risks and appropriate risk management options. This function relates strongly to the good governance principles of participation and inclusiveness.

Renn et al. (2007) stress that risk communication has to be understood as on open process of mutual alignment of information and concerns. The communication should include scientific knowledge, the coordination of relevant stakeholders and the public with regard to mitigation and adaptation options, the information of the assessment and evaluation criteria of the risks and benefits, the concerns of interest groups and the enhancement of a dialog (Renn, 2008 after: Zimmerman 1987; Lundgreen 1994; ad hoc Kommission 2003). However, one has to notice that the better knowledge of risk does not lead automatically to better decisions and/or better acceptance of risk prevention.

The communication activities can be classified in:

1. Documentation (transparency) – transparent knowledge transfer, transparent responsibility (multiple-level governance, multiple-actors, intersectoral)
2. Information (enlighten) – one-way transfer; e.g. awareness raising, informing on facts
3. Consultation; two-way transfer (dialog); e.g. exchange of knowledge amongst actors, levels of governance and in between sectors, understanding needs and concerns
4. Cooperation; participation in risk evaluation process and risk management procedure across sectors, levels of governance and actors in decision making or pre-decision making process.

Today risk communication stresses a two-way communication process and social learning of all risk governance participants. This dialogue gives public bodies on the one hand a means to communicate risk-related issues, and on the other hand a possibility to learn more about the fears, hopes, interests and implicit value systems of the stakeholders. They can obtain a feeling for the acceptance of measures, discuss alternatives, gain additional (practical) knowledge and may have the opportunity to overcome barriers. But this two-way process will only be successful by observing the basic rules for participation processes as described below.

The implementation of the concept of risk communication into risk governance processes "means that the linear model of dispensing policies from above must be replaced by a virtuous circle, based on feedback, networks and involvement from policy creation to implementation at all levels" (European Commission, 2001). Risk communication gives special attention to participation (participation of stakeholders and participation of the broad public) and its feedback loops. In the past few years the term multi-stakeholder processes emerged describing a process which aims at bringing together all major stakeholders in a new form of communication, decision-finding (and possibly decision-making) on a particular issue (Hemmati, 2002). It should help to find practical solutions by building new partnerships amongst a variety of stakeholders, across sectors and for multiple risks. Multiple stakeholder processes deal with how stakeholders from different backgrounds can work together and achieve consensus (Hemmati, 2002).

What are the potential benefits of stakeholder participation?

Major goals of stakeholder processes as applied in the CLISP model regions are to create an environment for participatory and collaborative research, to raise awareness for climate-related risks, to enhance dialogue between different policy fields, planning domains and interest groups, and to jointly develop possible adaptation measures. The main motivations to engage in stakeholder dialogue can be found in the many benefits that participatory processes offer. According to Pfefferkorn et al. (2006) and Lexer (2004), these include, inter alia:

- Decision-making on climate change adaptation and related risk management may often involve situations of conflict between different parties affected. In general, such conflicts tend to be inevitable, controversial and very complex. They emerge within some context which typically is defined by a complex array of factors, such as numerous parties, multiple issues, deeply held values, cultural differences, different "world views", scientific and technical uncertainty, and legal and jurisdictional constraints. In addition to this, the cross-sectoral nature of climate change adaptation issues further increases complexity. Methods for effectively managing such conflicts must be responsive to the inherent complexity of those conflicts (Walker & Daniels, 1997). Participatory approaches provide an appropriate framework for integrated consideration of these aspects.
- Participation fosters collaborative and mutual learning processes. This is in favour of growth of knowledge and often creates better and more sustainable solutions.
- Empirical, traditional and "everyday life"-knowledge of lay people can provide valuable technical expertise that becomes accessible by involving the local population and affected stakeholders. This may often act as a kind of corrective for researchers, planners and authorities. Participation may stimulate creative potential and frequently leads to surprisingly simple and innovative ideas for problem solutions.
- Local people are the best experts when it comes to knowledge on local conditions. On the contrary, experts from outside often lack specific local knowledge. Top-down expert decisions often tend to neglect local people´s needs, which cannot be recognized by exclusively applying rational technical expertise. In that regard, stakeholder interactions in CLISP allowed to learn more about issues and concerns in a region.
- Participation provides an environment for (often hidden) interests to be laid open and allows for reconciliation of conflicts within a controlled environment.
- Building acceptance for adaptation measures: Motivation and identification with decisions normally only comes through personal involvement of the stakeholders. Acceptance of decisions fosters commitment to their implementation and leads to better compliance with measures. Otherwise, there may be distrust and either active or passive resistance of local people concerned against implementation of measures, which might cause projects to fail and lead to expensive disinvestments. Even the best management plan is useless, if it fails because of a lack of compliance on the part of the local communities.
- Contrary to the common perception that participation is expensive, it can, in fact save time and money. Often, planning processes can be accelerated by participation because long delays due to formal objections, law suits and protest activities can be avoided. This reduces overall costs and also contributes to legal certainty for planners, authorities and project initiators.
- Open communication can contribute to de-emotionalizing debates. Though, in the very beginning the opposite effect may predominate. In order to identify and clarify conflicts, they first have to be raised.
- Participation can strengthen democratic awareness, conflict culture and regional identity.

Even though, in spite of its many advantages, participation has its limits and risks. Obstacles include, inter alia:

- Political abuse by instrumentalizing participation in order to legitimate certain decisions;
- Lack of resources (time, money), lack of knowledge as well as capacity for articulation and communication on part of local population;

- Failure due to group egoisms.

What are the principles of good risk communication practice?

In risk communication as in risk governance there are principles which should be considered and used as criteria to subsequently evaluate the performance in the project. In Section C 2.2.3 we introduced the principles on good governance, and as participation can be seen as a tool of good governance, good risk communication (in CLISP among multiple-stakeholders) builds on similar principles. Hemmati (2002) for example stresses that multiple-stakeholder processes (MSPs) for governance and sustainability are based on recognition of the importance of achieving equity and accountability in communication between stakeholders, involving equitable representation of stakeholder groups and their views. Furthermore the author considers democratic principles of transparency and participation as a need to MSP and the aim to develop partnerships and strengthened networks among stakeholders. Additional to these fundamental principles there are criteria specific to participation (see description below).

In Section C 2.2.3 the principles of good governance were introduced and build the fundament for good risk communication. In this context **good governance** means further developing the role of stakeholder participation and collaboration in (inter)governmental systems as supplementary and complementary vis-à-vis. Because the roles and responsibilities of governments should be based on clear norms and standards this should provide space for stakeholders to act independently where appropriate (Hemmati, 2002). Principles for establishing stakeholder participation can be found e.g. in the Austrian Standards for Public Participation (BMLFUW, 2008), in literature about public participation processes, handbooks, etc.

Principles / criteria for good communication

Flexibility: Covering a wide spectrum of structures and levels of engagement, depending on issues, participants, linkage into decision-making, time-frame, and so on; remaining flexible over time while agreed issues and agenda provide for foreseeable engagement (Hemmati, 2002).

Efficiency: A balanced proportion between resources invested in the participatory activities and the envisioned outcome, as well as the cost-effective use of deliberative techniques and methods (Renn, 2008).

Effectiveness: Providing a tool for addressing urgent sustainability issues; promoting better decisions by means of wider input; generating recommendations that have broad support; creating commitment through participants identifying with the outcome and thus increasing the likelihood of successful implementation (Hemmati, 2002).

Mutual respect: Public participation is a process of comprehensive involvement of the persons affected by or interested in decisions on policies, plans, programs, and legal instruments. All participants are aware of their different roles in such a process. They deal with each other respectfully. This enhances the good cooperation of all participants (BMLFUW, 2008).

Learning: Requiring participants to learn from each other; taking a learning approach throughout the process and its design (Hemmati, 2002).

Decision and feedback: The decision-makers take account of the results of the public participation process in decision-making. “Take account” means that they deal with the results respectfully and include them as far as possible in the decision. The decision should be communicated in a way taking reference to the subject matters of the public participation process. In this way politics and administration can express their appreciation of the participants’ contributions and build confidence (BMLFUW, 2008).

Competence: Ensuring that the state of the art in knowledge of the risk issue is considered during the deliberations and that all participants are made literate in the issue itself and in using deliberative reasoning (Renn, 2008).

Legitimacy: Requiring democratic, transparent, accountable, equitable processes in their design; requiring participants to adhere to those principles (Hemmati, 2002).

Ownership: People-centered processes of meaningful participation, allowing ownership for decisions and thus increasing the chances of successful implementation (Hemmati, 2002).

Partnership/cooperative management: Developing partnerships and strengthening the networks between stakeholders; addressing conflictual issues; integrating divers views; creating mutual benefits (win-win rather than win-lose situations); developing shared power and responsibilities; creating feedback loops between local, national or international levels and into decision-making (Hemmati, 2002).

Joint responsibility: Public participation means for all participants to accept responsibility for the jointly performed work and its outcome. In this way both the quality of the outcome and people's identification with it can be improved (BMLFUW, 2008).

Societal gains: Creating trust through honoring each participant as contributing a necessary component of the bigger picture; helping participants to overcome stereotypical perceptions and prejudice (Hemmati, 2002).

Clear mandate: Clear statement of what is being expected from the participatory exercise from the beginning, including a timetable, the scope and range of options, and a clear understanding about the nature and the future use of the outcomes of the deliberations (Renn, 2008).

Strengthening of (inter)governmental institutions: Developing advanced mechanisms of transparent, equitable, and legitimate stakeholder participation strengthens institutions in terms of democratic governance and increased ability to address global challenges (Hemmati, 2002).

Diversity: Bearing multiple perspectives and disciplines on the risk in question (Renn, 2008).

Professionalism: Structuring, moderating and facilitating the process and summarizing and disseminating the results (Renn, 2008).

What are the challenges of risk communication concerning climate change?

Risk communication plays a central role in the risk governance framework as an effective tool to communicate and exchange risk and benefits among competing stakeholders. The challenges strongly result from the inclusion of multi-stakeholders, different levels of governance, multiple-sectors and multiple-risks. Additionally, as of today we are not only looking at short-term risk management procedures, but also long-term sustainability in regard to climate change, the concept of uncertainty has to be understood and implemented at any level in the risk governance framework.

Building trust

Building trust in risk management institutions, in CLISP e.g. planning authorities, is one of the most important objectives in risk communication. It is important to find a common language, to understand the need of the audience and to honour each stakeholder's contribution in a participatory process.

Renn (2008) lists the following components of trust to make the term more operational:

- **Perceived competence:** Degree of technical expertise in meeting an institutional mandate.
- **Objectivity:** Lack of bias in information and performance as perceived by others.
- **Fairness:** Acknowledgement and adequate representation of all relevant viewpoints.
- **Consistency:** Predictability of arguments and behaviour based on past experience and previous communication efforts.
- **Sincerity:** Honesty and openness.
- **Faith:** Perception of goodwill in performance and communication.
- **Empathy:** Degree of understanding and solidarity with potential risk victims.

Trust will help to compensate negative risk perceptions, whereas distrust will lead people to oppose risks no matter how small. Nevertheless building trust as a main goal can also be seen critically described as follows in a literature review by Höppner et al. (2010): Frewer (2004) suggests that there has been a refocusing of the official goals of communication from changing public views on risk in the 1970s, to gaining public acceptance for the sources of risk and their management, and more recently, to the building of trust in risk management bodies. According to Höppner et al. (2010) Plough and Krimsky (1987) have argued that it was the need for risk managers to gain public acceptance for policies and technologies that significantly stimulated the study of risk communication in the first place. It is important to note that some authors have explicitly cautioned against an unbalanced re-emphasis on communication exercises that serve solely to increase public trust and consent, rather than on facilitating stakeholder and public dialogue as a contribution to mutual learning and innovation (Höppner et al., 2010 after Irwin 2006; Wynne 2006).

Choice of adequate communication and participation strategies

Communication strategies in risk government include the media, the broad public as well as (institutional) stakeholders. For media and communication with the broad public often traditional and well-known methods and tools are used. The broad integration of stakeholders is a relatively new approach for many administrations/institutions dealing with spatial planning. It is not only important to identify and inform all relevant stakeholders in risk governance processes, but also to raise interest to be involved in the process so that the stakeholders commit themselves and take on responsibilities. However, there are usually several interest groups and the adequate communication instruments have to be chosen. The selection will be described in detail in Section C 2.3.2.

Participation can take many forms, can be done with varied participants and can have different degrees of intensity: ranging from noncommittal activities with a focus on information activities to consultation activities up to a real inclusion of the public in the decision-making process or at least the pre-decision making. The kinds of intensity for public participation can vary within a process.

Basis for all participation processes is free access to information (Fleischhauer et al., 2010). An overview of levels of intensity of integration and stakeholder interaction can be found e.g. in BMVIT (2008):

- **Information:** Direct mail, postings, open access to maps (e.g. hazard maps), exhibition, print or electronic media
- **Hearing/consultation:** One to one conversation, discussion panel, workshop, working group, site inspection, conflict mediation, possibility to comment on the project on a webpage
- **Participation in decision making process:** Cooperative planning procedures, round table, open space event, mediation

This list is not exhaustive and the classification may differ from other publications but it shows how different the formal and/or informal interaction with stakeholders can be. The choice of adequate instruments depends on the specific settings for the stakeholder processes in each region.

Deal with uncertainties

Risk problems related to climate change are very often characterised by high complexity and high uncertainty. At present, and very likely also in the future, regional climate scenarios and climate impact assessments based thereupon are characterised by considerable uncertainties (uncertainties inherent to model projections, potential discontinuities in climatic development, choice of models, choice of emission scenarios, limited spatial resolution of regional climate scenarios, 'translation' of climate scenarios into spatially explicit impact scenarios, etc.). The uncertainty which is clearly related to climate projections, the consequences of changing climate in general and extreme weather events in particular belongs to the key challenges of adaptation to climate change. Coping with these multiple uncertainties is a central challenge in spatial planning under conditions of climate change. To a considerable extent these uncertainties will continue to exist, in particular on the regional and local scale, even if improved climate models and scenarios will be available. Planning, however, has to maintain its capacity of taking actions despite all uncertainties. See Section C 2.3.3 for a more detailed description on the theory of uncertainties and Section C 3.4 for an outline on communicating uncertainties.

(Possible) benefits of participation processes

High-quality public participation requires commitment, time, resources, energy, and last but not least specific skills as inputs – but it also produces numerous benefits and in the output the investment may pay multiple dividends. The Austrian Standards of Participation (BMLFUW, 2008) list possible benefits from well planned and well implemented public participation:

- Public participation involves those affected in the search for results.

- Public participation helps strengthen the climate of trust between politics, administration as well as those concerned and participants.
- Public participation raises people's interest in political participation and fosters lively democracy.
- Public participation activates; it makes the people affected by decisions participants and fosters development processes and participation projects.
- Public participation supports the community and mutual respect between politics, administration and participants as well as among the participants. Services rendered are to a greater extent mutually recognised.
- Participation processes are common learning processes and thus strengthen awareness-raising.
- Public participation makes the values and attitudes of participants as well as their interests and needs visible.
- Public participation fosters the comprehension for different points of view and for the problem to be solved. The flow of information is improved. The work of the administration is citizen-oriented, solution oriented and need-based.
- The cooperation between public administration and concerned interest groups reduces the pressure due to expectations and lobbying by individual interest groups.
- Public participation leads to innovative solutions, as all participants offer their knowledge, their practical experience and their creativity.
- Public participation facilitates the development of an accepted strategy. It fosters long-term solutions and therefore ensures planning security.
- Public participation designs decision-making processes in a way that they are transparent and traceable.
- In processes of public participation the fields of competence of the participating groups are clearly described and perceived.
- Public participation allows the involvement of the public in the process of decision making. Results can thus be accepted and backed on a broader basis. Thanks to the intensive cooperation participants can identify themselves better with the results.
- The intensive exchange between all participants permits the integration of different points of view, which improves the backing of results. In this way public participation also contributes to quality assurance and easier implementation. This means that public participation can have time- and cost-saving effects.

Barriers

Participation processes are impeded (after: Strategic Group on Participation, 2004; Fischer et al., 2004, p.80, Pfefferkorn et al., 2006, p.83),

if those (potentially) affected and interested fail to take part because:

- People are afraid of being "pocketed", meaning that by participating in the process they will be co-opted by other, and maybe stronger (lobbying) groups.
- People see other routes as more promising as regards getting their own way.
- People do not anticipate or expect any (personal) benefit from participation.
- There is a shortage of resources (time, information, money etc.).
- Channels of communication and people's ability to express themselves are inadequate.
- People have already had off-putting experience of participation.

if politicians do not identify with / support the process, because:

- Politicians are afraid that their scope for action and decision may be restricted.

- The outcome of the participation process conflicts with the politicians' general approach.

if there is no scope for action / organisation, because:

- Those involved are confronted with "faits accomplis".
- Key decisions have already been taken.

if social asymmetries persist throughout the process, because:

- Many of those (potentially) affected and interested are not reached; the participation process is not organised in a way that all segments of the population are in a position to take part.
- No specific efforts have been made to reach, invite and support segments of the population who have difficulties in articulating their interests.

if there is a permanent stalemate, a stand-off without progress because:

- Some of those involved feel that a participation process would weaken their own position.
- Some of those involved doubt that participation process would lead to an acceptable solution to everyone, so they simply defend their own position.

Additional barriers do occur:

- if an unsuitable level is selected for application;
- if it is not clear what will happen with the results;
- if information is missing or is not presented in a comprehensible form;
- if tensions interfere with people's working together;
- if expectations were raised but not fulfilled.

Participation processes are misused / instrumentalised if:

- a single individual or group presents solutions that have been worked out collectively as their own achievement in public,
- some new idea is presented as if it were part of the solutions that have been worked out collectively,
- the outcome of the process is presented only selectively and incompletely,
- the results achieved are not treated in the way agreed,
- the aim is purely to gain time – to put off a decision seen as unfavourable for a particular group as long as possible,
- the process is employed as "occupational therapy" to occupy groups with scanty resources and to distract them from important discourses.

What are the opportunities of climate change?

Even though there are many challenges of implementing adaptation to climate change in a region, the chances and advantages may outweigh the efforts in the long run. It is now accepted that it is necessary to adapt to climate change and that spatial planning can contribute to a successful process. Climate change may have negative impacts on existing structures, however due to adaptation strategies it might be possible to meet the future and make use of the changing environment. It is not only important to know about climate change and the impact but also to outline the future and explain the decision-processes to the stakeholders.

Most people now recognized that climate change is happening and that some sort of action has to be taken in order to minimize the negative effects some people may encounter. Because climate change is a long term process it is possible to take the chance to adapt to the changing environment and make the best of the future conditions. One example, often mentioned is that the winter tourism in the mountains decreases, however, in summer, due to cooler temperature the higher altitudes are becoming more attractive. However, the tourism sector has to invest into new infrastructures to meet the demand of a changing clientele.

2.3.2 Preparing and designing the stakeholder process

In the following sections, approaches and tools that may be useful in the preparation and planning of the stakeholder processes in the model regions will be outlined. One common approach to structure and to gather information on stakeholders is the context analysis. After a brief outline of the procedure in the next section the interest analysis will be explained in detail, as it is the base for building up a good communication structure in the model regions.

CONTEXT ANALYSIS

The context analysis can be used to get an overview of the interests in a region and to assess the status quo. The aim of a **context analysis** is to analyze the environment in order to develop a strategic plan of action. It also gives the opportunity to see which other relevant projects have been done in a region and to learn from those (positive and negative). Hostmann et al. (2005) summarized four dimensions:

1. **Historical context:** have climate change impacts already occurred; are any response/risk management/adaptation measures already in place; are there any spatially relevant developments with regard to climate change; are there any spatial conflicts (also not only related to climate change, as these may be the same stakeholders); etc.
2. **Legal context:** framework on how e.g. laws and regulations directly or indirectly determine spatial planning
3. **Political, economical and social context:** e.g. the needs and demands of stakeholders and their interaction in the communication process. This can influence the decision-making process and/or the implementation.
4. **Spatial context**: location of hazard zones and endangered objects in the study area, etc.

STAKEHOLDER ANALYSIS

In a **stakeholder analysis** a “long list” of possible stakeholders is prepared and subsequently analysed by different criteria or attributes (to be determined by e.g. a project team). After clustering the stakeholders a mapping procedure can be applied by the degree of stake or degree of influence. The process identifies potentially relevant stakeholders, but does not guarantee an active participation unless there is a sufficient interest raised. Referring to the statement: “Encompassing the combined risk-relevant decisions and actions of both governmental and private actors, risk governance is of particular importance in, but not restricted to, situations where there is no single authority to take a binding risk management decision, but where, instead, the nature of the risk requires the collaboration of, and coordination between a range of different stakeholders” (Renn, 2008), we would like to emphasize the importance of a precise stakeholder selection. Furthermore, as was pointed out in several studies (e.g. MIDIR, 2008), in a risk governance process, stakeholder involvement is a main contributing factor to a successful implementation. To support the stakeholder selection a stakeholder analysis makes the selection process of the participants itself transparent and can be used for the process documentation.

The main questions are:

- Who are the relevant stakeholders?
- What are their interests and expectations?
- What kind of information is assumed to be relevant for the stakeholders?
- What kind of dialogue process is suitable/applicable for stakeholder involvement? (Fleischhauer et al., 2010)

In general stakeholders are “interested parties”. In the context of CLISP stakeholders were:

- Those whose interests are affected by spatial planning and climate change or those whose activities strongly affect spatial planning and climate change adaptation
- Those who possess information, resources and expertise needed for strategy formulation and implementation
- Those who control relevant implementation instruments

(after: www.serd.ait.ac.th/ump/html/st.htm, adapted)

In a climate change adaptation context, not only the interests of different stakeholders have to be considered, but also that the effects of adaptation measures in a region on the interests of different groups have to be considered for each affected sector. For example, one sector in a region may profit from the adaptation to climate change whereas a competing sector may not.

INTEREST ANALYSIS

In the literature stakeholder analysis is often described similar or equally to the interest analysis. The **interest analysis** aims at "exploring interests behind positions, discover courses of action, promote building of trust and encourage the willingness to participate in a dialogue process by means of one-to-one interviews with relevant stakeholders" (MIDIR, 2008). Results of the interest analysis include a summary of the interests and their representatives, an overview of existing structures of collaboration and experience of cooperation, an estimation of chances for agreement and suggestions for further procedures (information-, consultation- and/or common decision making activities) (*Table 1*).

Why should you do interest analysis?

- To identify conflicts of interest
- To ensure inclusion of all relevant stakeholders
- To help design and implement participatory planning and management processes
- To identify appropriate forms of participation
- To interact more effectively with key stakeholders
- To maximise the role and contribution of each stakeholder
- To identify stakeholder relations that can enhance cooperation, support and ownership
- To lay the ground work for monitoring and adaptive management
- To increase support for adaptation strategies that are developed in the project

Stakeholder analysis by itself only identifies potentially relevant stakeholders – it does not ensure that they will become active and meaningful participants. By the right choice of communication tools the interest of different interest groups should be raised and subsequently a sustained commitment fostered. The spectrum of stakeholder positions may range from supporters over neutral stakeholders to opponents.

How to perform an interest analysis?

a) Identify stakeholders (e.g. brainstorming, dialog and recommendations by already selected stakeholders/snowball-system)

b) Determine their interests relative to spatial planning, risk management and climate change adaptation (e.g. dialog with stakeholders, questionnaires, expert opinion)

c) Group the stakeholders by interests, if possible, to reduce the number of stakeholders to ensure intensive work, but ensure that all possible interests are represented

d) Assess the impact of spatial planning and climate change adaptation on the interest groups and determine the influence of the same group

Identify the appropriate degree or intensity of stakeholder participation (ranging from information to consultation up to inclusion in decision-making process; **Fehler! Verweisquelle konnte nicht gefunden werden.**). Please consider that different stakeholders may have different roles during the project or during project steps.

Table 1. Example for organizing interest analysis

Interest groups	Stakeholder	Power/influence (high, medium,low)	Level of interest (high, medium, low)	Conflicts and impacts between and from stakeholders

To assess the appropriate level of participation of stakeholders in the risk management process it is possible to classify them with a power/interest grid (*Figure 3*):

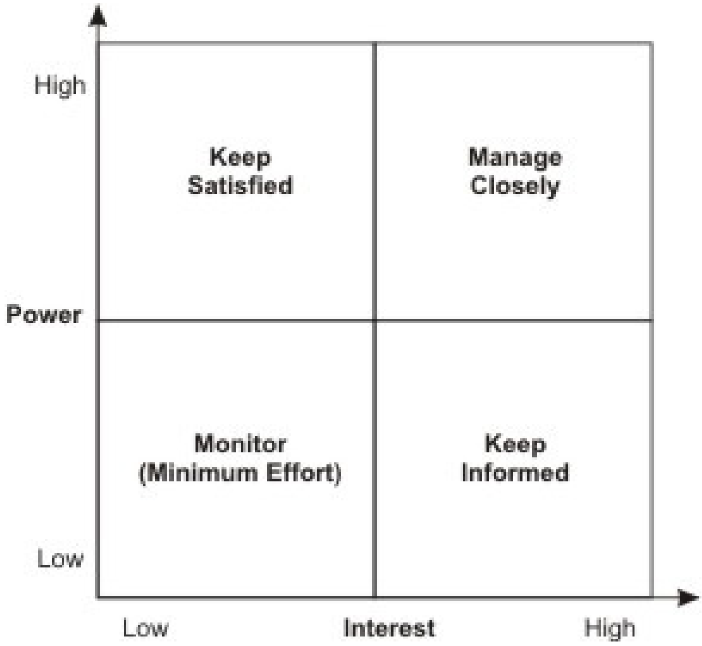

Figure 3. Power/interest grid for stakeholder classification (after: www.mindtools.com/pages/article/newPPM_07.htm)

- **High power, interested people:** these are the people you must fully engage with, and make the greatest efforts to satisfy.
- **High power, less interested people:** put enough work in with these people to keep them satisfied, but not so much that they become bored with your message.
- **Low power, interested people:** keep these people adequately informed, and talk to them to ensure that no major issues are arising. These people can often be very helpful with the detail of your project.
- **Low power, less interested people:** again, monitor these people, but do not bore them with excessive communication.

Please consider that different stakeholders may have different roles during the project or during project steps.

In addition, the **network analysis** is mentioned here briefly. A **social network** is a social structure made of nodes (which are generally individuals or organizations) that are tied by one or more specific types of interdependency, such as values, visions, ideas or conflict. Social **network analysis** views social relationships in terms of nodes and ties. Nodes are the individual actors within the networks, and ties are the relationships between the actors. The resulting graph-based structures are often very complex. Social networks play a critical role in determining the way problems are solved. These concepts are often displayed in a social network diagram, where nodes are the points and ties are the lines and may help to choose the relevant stakeholders. It is a tool to find out who is connected to whom and who the most influential stakeholders are.

Table 2. A typology of stakeholder engagement in climate change research (Carney et al., 2008)

Role played in the research process	***Description***

Initiators	Stakeholders involved in developing, driving or instigating a piece of research, e.g., funders.
Shapers	Stakeholders who have a role in consolidating a research plan, supporting it or directing it at an early stage. This may include an expansion in the scope of the research to gain buy-in and provide the research with legitimacy.
Informants	Those stakeholders who directly inform a research study, e.g., secondary data providers, interviewees, focus groups, etc.
Central	These stakeholders have an input throughout the research process; they play a focal role. They may take on a multitude of roles, as shapers, informants, reviewers, reflectors, etc. They may be representatives of broader groups or organizations and tend to be close to the research, for example they are often part of an 'advisory group'
Reviewers	Before completion, stakeholders who have a role in reviewing research, responding to it and shaping / contributing to aspects of the final output. This maybe elicited in the form of questionnaires, focus groups, interviews, workshops, etc.
Recipients	Stakeholders who may not have been directly involved with the research but who are deemed to have a specific interest in its findings.
Reflectors	These stakeholders reflect on the research findings and/or the process, providing feedback for development of the research, the methods and providing ideas for further research.
In-directs	This group represents wider stakeholders who are not explicitly included with the research. However, they may be unknowingly or unconsciously contributing to it – or affected by it.

2.3.3 Uncertainties

Climate change and its potential impacts are one of the most studied problems of our time. Uncertainty is a major issue that has to be considered. Uncertainties can directly affect decisions and policy in climate change assessment, mitigation and adaptation. Hence it is of great importance to know about the potential sources of errors and the uncertainties of the results. The second major issue of climate change assessment is to find a proper way to communicate the uncertainties of the results. Depending on the end-user there might be different solutions on how and what to communicate. In the last decades, great progress has been made in predicting the future climate and in determining the potential impacts. However, in the case of climate change assessment it is important to quantify and communicate the uncertainties inherent in the results. Therefore, uncertainty analysis should be an indispensable part in any kind of risk analysis or decisions based on climate change impact studies. The communication should be clear and open, also stating alternatives. This will strengthen the acceptance and confidence in the decisions and subsequently facilitate an easier implementation.

Sources of uncertainty

In the case of climate change impact studies, uncertainties are present in various domains of the research area. For instance, the climate change scenario itself contains several sources of uncertainties. Errors can occur in the initial climate conditions, the structure of the climate model or in the used emission scenario. The method for estimating the potential impacts of climate change normally also implies sources of error. Hence, beside the uncertainty of the different domains themselves, the propagation of the uncertainties is another important point to be considered, in order to determine the potential error of the final outcome. When climate change information is applied to impact assessment, the incorporation of climate change and impact assessment related uncertainties can produce a very large range of possible impacts. This propagation of uncertainties is sometimes termed the cascade of uncertainties or uncertainty explosion (*Figure 4*) (Jones, 2000). Morgan and Henrion (1990) and Katz (2002) categorized the potential sources of uncertainties in climate change impact studies into three groups: measurement errors, variability and model structure.

Measurement errors

Measurement errors can arise for two reasons: The first source of error is the measurement instrument itself, which is subject to a random error, the precision. The second source of error stems from wrong handling of the measurement instrument that causes a systematic error, called bias. It is more or less straightforward to determine the precision of a measurement instrument. In the case of the bias it can be more difficult and this component of measurement error is therefore often ignored (Katz, 2002).

Variability
Even though measurement errors are common in researching climate change, the dominant factor concerning this issue is variability. This term reflects the systematic differences over space and time as well as inherent randomness of environmental or geophysical processes (Katz, 2002). Especially in the case of precipitation the contribution of the spatial variability is much higher than that of the measurement error to the overall uncertainty of measured precipitation values.

Model structure
The probably most important and at the same time the most problematic sources of errors are the employed models themselves, or rather the model structure. Simplifications and parameterizations in the models are more likely to have a substantial effect on the results of the analysis than uncertainties in the input data (Katz, 2002; Nilsen and Aven, 2003). Though model uncertainty is a topic widely discussed in the common literature, there is no consensus on how to measure it or assess its impact on the application of analysis results in decision processes (Nilsen and Aven, 2003).

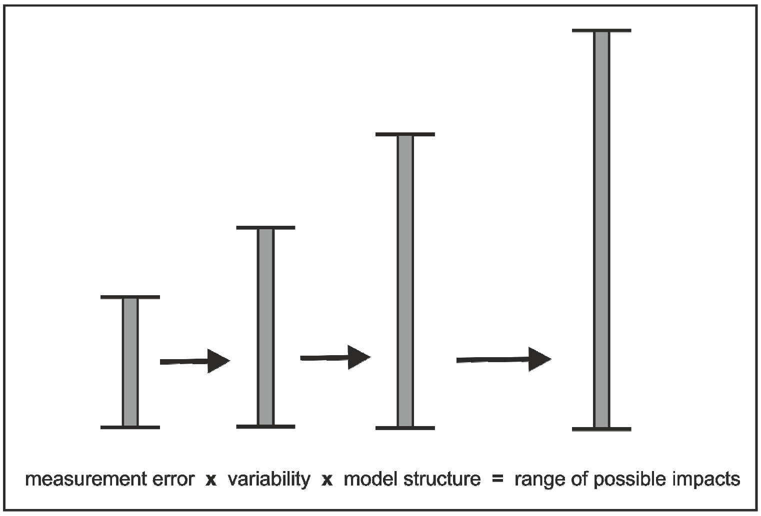

Figure 4. Cascade of uncertainties in climate change assessment.

Types of uncertainty analysis

In the last decades various techniques have been developed to determine uncertainty in climate change scenarios and impact studies, the most common and currently used of which include the sensitivity analysis, the scenario analysis, Monte Carlo uncertainty assessment and the Bayesian uncertainty assessment (Morgan and Henrion, 1990; Greenland, 2001; Katz, 2002).

Sensitivity analysis
In the case of sensitivity analysis, one input parameter is varied by a defined interval, keeping the other inputs constant. The changes this variation causes in the model output are then critically evaluated (Katz, 2002). In the last decades multiple sensitivity analysis has been performed, taking into account more than one input parameter simultaneously and also dealing with uncertainty in inputs (Saltelli et al., 2000). Thereby the omitted uncertainties in the input data are added and the potential effects on the result can be studied. Hence, sensitivity analysis is a sound methodology for identifying whether the model output is relatively sensitive to changes of particular input parameters. Additionally it is possible to determine how known uncertainty in the input values (measurement errors and variability) affects the results of a model. However, errors caused by the model itself are not definable using sensitivity analysis.

Scenario analysis

Scenario analysis is a kind of multiple sensitivity analysis, but instead of varying only a few input parameters by an defined interval, all the inputs are changed simultaneously, typically at a much higher rate (Katz, 2002). Scenario analysis is a feasible method to produce changes in the results of models that correspond to realistic input variations. In case dependencies exists in the data (e.g. a change in precipitation causes a variation of temperature or humidity), scenario analysis is a sound technique to consider such interactions. After Morgan and Henrion (1990) scenario analysis is not an adequate technique for defining uncertainty. Thus, with the help of scenario analysis individual scenarios can be created, which reflect e.g. baseline or worst-case scenarios and therefore variability can be taken into account. Hence, scenario analysis is a common technique in recent climate change impact studies and is more policy relevant than a traditional sensitivity analysis. However, uncertainties of the model itself and measurement errors are not definable with the use of scenario analysis.

Monte Carlo uncertainty assessment
The Monte Carlo method is a class of computational algorithms that rely on repeated random sampling to compute their results. In essence, the inputs are randomly drawn from probability distribution for each individual input parameter and the corresponding output determined (Katz, 2002). Hence, given the availability of a distribution of the inputs, it is possible to create a probability distribution for the model output. One hindrance in the issue of climate change is to generate large enough ensembles for uncertainty analysis in consideration of the computational effort. Even so, for not too complex models the Monte Carlo method is a good way to determine the impacts of measurement errors and variability on the results and therefore the uncertainties of the results. However, errors caused by the model itself are also not definable by using this method.

Bayesian uncertainty assessment
The use of Bayesian statistical methods for estimating uncertainty is not new, but faster computers have contributed to the comeback of these methods in recent years. The Bayesian approach requires a prior probability distribution for the model parameters, but it also makes it straightforward to combine different sources of information, e.g. updating the posterior distribution through taking the previous posterior distribution to be the present or taking more than one model into account (Hobbs, 1997; Katz 2002). Thus, the uncertainties of the model structure can be reduced by the use of Bayesian statistics and the remaining uncertainty can be defined. Furthermore, the possible impacts of measurement errors and variability on the results and therefore the uncertainties of the results can be determined with the help of this method. Another feature of the Bayesian analysis, which makes this approach even more valuable, is the comprehensive and coherent framework that Bayesian uncertainty assessment represents (Hobbs, 1997).

The question remains of what strategy to adopt, a fully probabilistic analysis via Bayesian uncertainty assessment looks like a good way to define the uncertainties in climate change assessments. Though, it is important to acknowledge that sensitivity analysis, scenario analysis and Monte Carlo uncertainty assessment still are needed, as such analysis can serve as catalysts for further examination of uncertainties (Katz, 2002). However, in some cases it would be sufficient to stick with e.g. scenario analysis in order to determine the impacts of given evolutions of the future climate. Please refer to Section C 3.4 on the communication of uncertainties.

3 The Potential Role of Risk Governance and Risk Communication in Spatial Planning

3.1 The role of risk governance in spatial planning

The expected increase in future risk potential due to climate change calls for improved risk-related decision-making in spatial planning, including consideration of the multiple uncertainties connected with estimated climate change scenarios. That is why risk governance principles including the entity of actors, rules, conventions, processes and mechanisms concerned with the management and communication of climate change-related risks should be promoted in planning procedures where appropriate. Combining bottom-up and top-down processes is essential for including the knowledge and values of all stakeholders.

According to Rudolf-Miklau (2009) risk governance is based on balanced considerations of public and private interests and a fair distribution of risks. Regarding the role of spatial planning this could imply that planners would need to act to an increasing extent as moderators of discourse and negotiation processes, communicators and risk managers (Lexer et al., 2008). Risk communication plays a central role in the successful implementation of risk reduction measures, including adaptation strategies, especially in areas where a high number of stakeholders are involved in the pre-decision-making process or the decision-making process itself and extensive cooperation is required. Furthermore, Greiving et al. (2006), in an article on spatial planning in times of climate change, emphasise that informality in decision making processes become more important, because e.g. the incorporation of a risk governance concept allows the reduction of uncertainties in the planning procedure and the acceptance of decisions can be fostered.

The focus of the CLISP project was on climate-related risks that are relevant to spatial development. In this context, risks are to be understood as uncertain consequences of climatic changes and of climate change impacts on natural and socio-economic systems with respect to something that humans value (Renn, 2005). Often climate change adaptation by spatial planning is seen as an option for preventive approaches to increasing risks (e.g. Paleo, 2009). The same author stresses the need for cooperative planning of different levels of government to secure local government in participation and make planning sustainable. In addition, cross-sectoral cooperation is indispensable as climate change is a cross-cutting issue, and to respond effectively in risk management, participatory decision-making processes need to be improved by differentiating among their types and applications.

Applying the risk governance concept to spatial planning in general and in more detail to climate change adaptation by spatial planning will however not only bring advantages to risk management. Walker et al. (2010) point out positive and negative implications caused by shifts to governance for the management of natural hazards. Similarly *Table 3* summarizes some of the promoted aspects of risk governance, including risk communication in spatial planning. Details will be explained below.

Some of the potential negative impacts listed above can be counteracted by using tools for stakeholder analysis or for assessing the risk governance structures. An example of such a tool is a risk governance indicator system (used in the MIDIR and CRUE-IMRA Project – *Figure 5*). In this tool the abstract principles of good governance are detailed and operationalized in key-questions, objectives and a key performance indicator.

It should be underlined, that the used measurement values as well as the classification have an exemplary function. It is necessary to define them according to the requirements of the responsible institution/body and situation/circumstances (Fleischhauer et al., 2010).

Keyword	Key-Question	Objective	Key-Performance-Indicator
Principles	What are the guiding principles?	Definition of guiding principles and a consistent "target system".	Degree of operationalisation of the guiding principles.
Trust	How far is attention paid to relevance of an atmosphere of mutual respect and trust?	Between all relevant stakeholders and decision makers an atmosphere of mutual respect and trust exists.	Reflection of trust concerning people/institutions.
Objectives	What are the concrete protection goals for subjects of the protection?	Definition of a comprehensive and obligatory understanding of the damage-protection-relation.	Degree of obligation concerning the protection goals for the subjects of the protection.
Accountability principle	How far is accountability defined at each level (process, each risk)?	Each actor knows his responsibilities and acts accordingly.	Definition of the responsibility.
Justification	How far is the activity concerning the management of existing risks justified?	Justification of action in the area of risk management.	Definition and agreement on a justification concerning the exposure to risk.
Representation	How far are all relevant social groups (and their representatives, stakeholder respectively) and their expectations known?	Identification of all relevant social groups and their expectations.	Degree of high profile of all social groups and their expectations.
Access to information	How far is information for all stakeholders accessible?	Access for all stakeholders to the relevant information.	Degree of the availability and understandability of the relevant information for stakeholders.
Tolerance process & outcome	How far do the stakeholders tolerate/accept the risk governance process and its outcomes?	All involved stakeholder tolerate/accept the risk governance process and its outcomes.	Degree of the tolerance/acceptance on the part of involved stakeholder.
Dialogue	To what extent is a constructive dialogue with the relevant stakeholders available or conducted?	Establishment of custom discourse-processes concerning risk topics.	Quality of discourse-processes with relevant stakeholders (i.e. public or private representatives).
Financial Resources	To what extent do the available financial resources meet the requirements of the defined Risk Governance Process?	Allocation of sufficient financial resources for a successful risk governance process.	Degree of realisation of a financial concept.
Stuff Resources	To what extent do the staff resources (technical qualification and number of people) meet the requirements of the defined Risk Governance Process?	Allocation of adequate staff resources.	Realisation of a staff assignment concept.
Role	How far has the role of experts been defined?	If experts are involved, their role within the decision-making process have to be defined.	Degree of definition and agreement concerning the role of experts.

Figure 5. Overview of Key Performance Indicators (Fleischhauer et al., 2010)

Table 3. Aspects of risk governance and its impacts in regard to spatial planning

Aspect of risk governance	Potential positive impact	Potential negative impact
Intersectoral cooperation	• Shared knowledge (transparency) • Climate change requires intersectoral problem solving • Better management of dependencies • Mutual understanding • Innovative and sustainable solutions • More efficient spatial planning	• Question whose knowledge is taken into governance • Sector dominance
Multiple-level governance	• Clear responsibilities • Capacity building on lower level of governance	• Lack of capacities on lower levels of governance • Unclear responsibilities (if not transparent)
Multiple-actor networks	• Better acceptance of decisions • Easier implementation • Accounting for needs of various actors by mutual understanding • Distributed responsibilities • New capacity for joint local action	• Slow decision and implementation process • Disadvantages for those with fewer resources • Private sector may benefit from disasters

3.2 Managing intersectoral interdependencies

According to Kalegaonkar and Brown (2000) the first decision is if intersectoral cooperation is appropriate for managing a specific risk. With regard to climate change adaptation this seems true as mono-sectoral problem-solving is unsatisfactory and information and resources are held in more than one sector. Intersectoral cooperation aims at achieving mutual understanding regarding an issue and negotiating and implementing mutually agreeable plans for tackling the issue once it has been identified (Kalegaonkar and Brown, 2000). Climate change impacts will affect more than one sector in a region and the management of intersectoral dependencies will play an important role in an effective and sustainable spatial development. In sectoral planning the minimization of the risk most important to the sector was in the foreground without considering spatial risk reduction measures. However, problem-solving requires information and resources held in more than one sector (Kalegaonkar and Brown, 2000). In the sector spatial planning the information of different other sectors has to be incorporated and harmonized in development plans, which in return have an effect on the development options in different sectors. In an effective spatial planning process the flow of practical knowledge from intersectoral cooperation will help to share existing experience to efficiently manage dependencies in the risk governance framework. This fosters an intersectoral problem solving approach leading to more sustainable results and increasing the acceptance of planning outputs, by considering the needs of different sectors. In regard to climate change spatial planners request clear messages from sectoral authorities on how to deal with climate change impacts, which requires the management of intersectoral dependencies.

How to manage cross-sectoral aspects

The CLISP project has shown that spatial planning experts request a clear planning basis from sector authorities in charge of hazard management on how to deal with climate change impacts on hazards.

Kalegaonkar and Brown (2000) in their study on development pointed out three lessons learnt in managing intersectoral dependencies: 1. Starting intersectoral cooperation, 2. Managing intersectoral cooperation, and 3. Challenges in intersectoral cooperation. In principle the same difficulties occur regarding climate change adaptation by spatial planning. The need and value for intersectoral cooperation has to be accepted before establishing a structured cooperation. A joint development and agreement of plans is required, because as the interests, goals and ways of working maybe different across sectors and the active participation of all sectors leads to accept responsibility for the jointly performed work and its outcome. In this way both the quality of the outcome and people's identification with it can be improved (BMLFUW, 2008). However getting from defining shared goals to a successful implementation of plans will cause difficulties. Mutual gains are a key element to drive and sustain intersectoral cooperation.

1. Starting intersectoral cooperation

- Build on and strengthen existing networks, if already existent.
- Find conveners with credibility to bring all the relevant parties (across the sectors) together
- Frame problems to emphasize the need for and mutual gains from multi-sectoral participation
- Balance power differences to enable shared problem definition
- Build relationships across the differences
- Foster multisectoral participation, as this may lead to higher acceptance

2. Managing intersectoral cooperation

- Develop shared plans that identify roles, responsibilities, and resources
- Foster mutual influence in decision-making. Consequently, organizational structures or processes that enable all parties to participate in shaping the outcomes are critical
- Manage conflicts in implementation phase
- Seek and identify mutual gains
- Develop agreements on implementation to hold each other accountable for program performance.
- Disagreements are inherent to cooperation, but clearly communicating and negotiating will help to reduce the potential for misunderstandings and conflicts. This is especially of interest in implementation.
- Creating formal processes or organizational structures, such as forums and advisory groups, can foster mutual influence in decision making and maintain it throughout the lifetime of the initiative.

3. Challenges to intersectoral cooperation

- Co-optation that reduces contributions of party differences
- Inequitable distributions of costs and benefits
- Past experiences that shape future cooperation

3.3 Managing different levels and actors of governance

Spatial planning systems are organised in a distinct vertical hierarchy that may encompass the national, the provincial state, the regional and the municipal level, depending on the respective government system. The same applies to many sector authorities responsible for risk and hazard management. More often than not, the assignment of competences to territorial levels of government is not coherent between spatial planning and sector planning on risk and hazard management. This generates a multi-level governance structure within and between sectors that accounts for a complex structure in risk governance and is extremely challenging in terms of coordination and cooperation requirements. Climate change adaptation by spatial planning is not only subject to intersectoral dependencies, but also to the interaction of different levels of governance and multiple stakeholders. Local participation and networks can empower those in lower levels of governance; however this may lead to a stronger lobby of some actors or sectors.

Managing relations between different levels of governance is a necessity, because this may lead to a long-term reduction of climate change risks (OECD, 2009) and acceptance of adaptation measures. In order to achieve effective and efficient multiple-level governance, the structures and capacities at all levels of government must be in place (OECD, 2009). Simultaneously vertical (across different levels of government), horizontal (among the same level of government, intersectoral) and networked relationships have to be accounted for (OECD, 2009), which is also the case when applying new governance concepts to spatial planning. In this case sharing knowledge and experience may lead to effective and efficient planning and implementation procedure, especially because climate change requires an intersectoral approach to problem-solving.

According to the OECD (2009) the five most common challenges that can hinder effective multi-level governance are:

1. Information gaps, due to unequal availability of information (quality and quantity) at different levels of governance
2. Capacity gaps, due to lack of human knowledge or infrastructural resources available to carry out tasks regardless of level of government
3. Fiscal gaps, due to insufficient financing on lower levels and therefore dependence on higher level governance
4. Administrative gaps, due to different higher and lower level administration borders
5. Policy gaps, due to purely vertical approaches by ministries to cross-sectoral policies that can require co-design or implantation at the local level.

The last point stands for a lack of intersectoral coordination, which was identified in the CLISP project as an important barrier in climate change adaptation by spatial planning. In the concept of risk governance of climate change induced risks, the coordination of multiple levels of governance and multiple sectors requires capacity building on all levels of governance, which should lead to bridging gaps. The OECD (2009) names legal mechanisms, contracts and various methods of municipal cooperation as means of establishing functioning relationships with respect to e.g. joint responsibilities.

In order to underline the necessity of a multi-level governance approach the OECD (2009) observed that: “sub-national governments are demonstrating a strong ability to accomplish functional tasks; but as demands become more strategic, for example in planning for sustainable development, the capacity of the sub-national level is often insufficient or shows important disparities among local actors”.

A tool for assessing intersectoral risk governance by following risk governance principles was developed in the project MIDIR and additionally tested in the CRUE-IMRA project (*Figure 6*). It is a self-assessment tool enabling a first classification of the status of intersectoral cooperation:

In the CLISP model regions the shift in climate change risk governance from mitigation to adaptation can be seen in various degrees. Also according to Walker et al. (2010) “shifts of responsibility have been associated to some degree with a shift from a stance based upon mitigation to one focused upon resilience and adaptation”. Mitigation is seen as national concern, whereas awareness raising should be governed on a local level with local understanding. Thereby those at risk – households, businesses, farms, infrastructure managers etc. – are instated as managers of that risk and become part of the multi-scale risk governance network (Walker et al., 2010).

How to manage multiple levels of governance

In the survey of risk governance structures in the model regions, the priority of cooperation and coordination was rather seen in intersectoral aspects. Mostly the legislation clearly defines responsibilities and managing between the levels of governance is not always seen as an advantage. In addition risk governance does not concern all levels, as is the case in spatial planning. However it became apparent that climate change issues are perceived as national interest.

1. Starting multiple levels of governance: Identify good level of governance; define clear responsibilities
2. Managing multiple levels of governance: Define clear responsibilities; spatial relevance
3. Challenges to multiple level governance: Flexible structures; allow participation, if appropriate

	Red Not started	Orange Beginning	Yellow Developing	Green Performing	Blue Improving
Principles	No guiding principles	Discussion process about guiding principles started	All guiding principles are defined	Discussion concerning the "target system" started	Principles through a consistent system of objectives – which are continuously reviewed and, if applicable, adjusted – are operationalised
Objectives	Subjects of the protection and protection goals are not defined	Process of discussion concerning the subjects of the protection and protection goals is initiated	Subjects of the protection and the protection goals are defined	Obligation for protection goals is requested	Protection goals are continuously reviewed and, if applicable, adjusted
Trust	Not to breach the issue of trust		Trust is discussed on a case-by-case basis		Trust is systematically reflected and, if applicable, trust building measurements are made
Accountability Principle	Responsibilities are not defined	Process of discussion concerning the definition of responsibilities started	Responsibilities are defined	Responsibilities are implemented	Responsibilities are continuously reviewed and, if applicable, adjusted
Justification	No justification	Discussion about the justification started	Justification exists	Justification as a part of obligatory arrangements	Existing justification is continuously reviewed and, if applicable, adjusted
Representation	Neither social groups nor their expectations are known	Process of the identification of stakeholders (e.g. through an interest analysis)	Social groups are known	All interests are represented and interested in the dialogue	Continuous feedback and monitoring with all stakeholders
Access to Information	Risk information is not available/accessible	Discussion about the intermediation of the risk information started	Guidelines for information policy are available (incl. determination of access rights)	Guidelines for information policy are applied	Continuous quality control (understandability and availability of information)

	Red **Not started**	**Orange** **Beginning**	**Yellow** **Developing**	**Green** **Performing**	**Blue** **Improving**
Tolerance process & outcome	Tolerance/acceptance of the process & outcome are ignored	Discussion about the creation of tolerance/acceptance started	Criteria concerning the measurement of tolerance/acceptance defined	Measurement of tolerance/acceptance is part of the process	Deficiency of tolerance/acceptance leads to a checkup of the process and/or its results
Dialogue	No discourse available	Discussion about the initiation and elaboration of discourse processes started	Interests and expectations concerning the discourse processes are known	Dialogue concepts are accepted by the participants (i.e. agreement on objectives, competences, duties and responsibilities)	Discourse processes are an integral part of the risk governance process and consequently reviewed
Financial resources	Costs and benefits of the risk governance process are not monetized	Calculation of costs and benefits is initialized	Relationship of costs and benefits is transparent	Financing is possible	Sufficient funds are available, the requirements are continuously reviewed and if applicable adjusted
Staff resources	No consideration of staff assignment	Conception of required staff assignment is initiated	Quantity and competences are defined (staff appointment scheme)	Selection procedure is working	Adequate staff resources are available, continuously reviewed and if applicable adjusted
Role	Experts' role not defined	Definition of the problems/questions and requirements concerning (external) expertise, e.g. science advisor, communication, consultant, evaluator…	Possible experts known by name	Agreement of the process participants to experts' role and persons named	Expertise is integrated into ongoing processes, including performance review

Figure 6. Scorecard for risk governance performance (Fleischhauer et al., 2010)

3.4 Communication of climate change induced risks, including uncertainties

The communication of uncertainties in climate change induced risks is an important, but difficult task. Besides the uncertainties inherent in climate and impact models there are subjective risk perceptions and the matter of how, when and what to communicate to whom is essential to come to a sustainable solution. Most risks are changing over a longer time span and often stakeholders from the private sector such as ski areas have a mismatching planning horizon. For example a ski area calculates its benefits for a 20 year period. Up to that point the mitigation measures applied (e.g. artificial snow making) are sufficient. However, a sustainable adaptation strategy has to take into account the time after that specific planning horizon.

The most cited risk governance framework, as introduced in Section C 2, is Renn (2005). Apart from the risk pre-assessment, risk appraisal, characterization and evaluation and risk management, risk communication plays a central role in the whole framework concept and should be an integral part of all other elements. Höppner et al. (2010) in their discussion of risk communication describe that “more recently, there has been a tendency to understand risk communication as an interactive exchange rather than a one-way transfer of information, knowledge and opinions among/between those responsible for managing risks and those who may be affected by hazard events”.

In the context of climate change adaptation by spatial planning in a risk governance framework, communication consists of four types (as outlined in Section C 2):

Ensuring a stakeholder-focused process means consulting and involving key persons and representatives of all possible concerned interests. The need for an extensive communication process can be justified on the one hand by the differences between “true” and perceived flood risk as described before, but on the other hand also by trying to improve the existing political, administrative, social and economic governance structures within local or regional communities (Fleischhauer et al., 2010).

Höppner et al. (2010) “see risk communication as a preventive activity that prepares communicating actors for hazard events, that enables them to better cope with hazard events and which helps to reduce adverse impacts on people and social systems”. This is specifically addressed to natural hazards and response to disaster. For spatial planning risk communication can be seen as a preventive activity that prepares communicating actors for climate change induced hazards, that enables them to better understand the need for adaptation to climate change by spatial planning and benefits and which helps to reduce adverse impacts on people and social systems. This indicates the many functions of communication in risk governance. Walker et al. (2010) observe accordingly a move from simple to complex models. The authors state that “the increasing number of actors that are perceived to have a legitimate stake or right to be involved in risk management and governance comes with multiplying expectations of how risk communication should be enacted and what it should ideally achieve”.

In the literature risk communication generally takes a management perspective and may serve to (after Höppner et al., 2010):

- raise awareness;
- encourage protective behaviour;
- inform to build up knowledge on hazards and risks;
- inform to promote acceptance of risks and management measures;
- inform on how to behave during events;
- warn of and trigger action to impending and current events;
- reassure the audience (to reduce anxiety or ‘manage’ outrage);
- improve relationships (build trust, cooperation, networks);
- enable mutual dialogue and understanding;
- involve actors in decision-making.

Höppner et al. (2010) also reports that government and expert bodies may still in reality be the primary if not sole actors involved in most of the core elements of risk governance. This was also reported in some of the CLISP model regions (e.g. Alessandria).

Communicating uncertainty

There are uncertain future conditions and associated risks (Langsdale, 2008), however actions have to be taken to guarantee a sustainable future.

According to Langsdale (2008) there are three challenges to communicating uncertainty to stakeholders:

1) **Uncertainty intolerance**: uncertainty is unacceptable and indicates faulty or incomplete science; scientists and engineers are able to accept uncertainty; politicians and public tend to be "risk averse and regard uncertainty as not only unacceptable, but also as someone else's fault" (Langsdale, 2008 after Clark 2002: 353)

2) **Over-confidence in model results**: too much confidence in highly unreliable data

3) **Omitting complex, uncertain aspects of the system in analysis**: reluctance to consider elements for which we have limited understanding (e.g. climate change in planning activities)

When dealing with impacts of climate change there is always a certain degree of uncertainty involved in the results that subsequently goes into the decision process. In case the uncertainties of these results are quantified, the issue remains of how to communicate these uncertainties to the end user, e.g. decision-makers and the public. Hence, one big task for climate change assessment is making information about uncertainty accessible and useful to the end user. The first prerequisite is identifying the target audience of the assessment, and conducting the assessment in such a way that it fits with their cognitive capabilities, choice opportunities, and level of experience with scientific information (Patt and Dessai, 2005). The stakeholder analysis tool as introduced before can be used for this task.

One way to express uncertainty is to disseminate the probabilities of the uncertainties. For results from a statistical analysis, it might be good to express them in the form of likelihood ranges or confidence intervals, if the end user knows how to read and interpret them. However, for people with a non-scientific background, this presentation of uncertainties might be confusing and will lead to misinterpretations of the results (Briscoe, 2004; Patt and Dessai, 2005). In order to best communicate uncertainties, Langsdale (2008) favours a scenario approach, because scenarios provide a clearer picture of the range of future states possible, rather than representing the uncertainty with error bars or statistics. The choice depends on the target group. Presenting the scenarios through a decision support tool can provide a framework for stakeholders to manage and evaluate the scenarios effectively (Langsdale, 2008).

In the field of climate change assessment it is often argued that it is preferable to provide decision makers with only qualitative information about uncertainty, instead of probabilities (Katz, 2002; Briscoe, 2004; Patt and Dessai, 2005). The probabilities are therefore often translated into qualitative terms, e.g. likely or very likely. This is also the way uncertainties are expressed in the IPCC's fourth Assessment Report (IPCC, 2007). Though, the qualitative terms expressing the probability are clearly linked to confidence levels and likelihood ranges (Table 4, Table 5). Still, using precisely defined probabilistic terms does not eliminate the possibility that policymakers and the public will misinterpret statements on climate change and related impacts (Briscoe, 2004).

Table 4. Description of the uncertainty in the IPCC fourth Assessment Report, where uncertainty is assessed more quantitatively using expert judgment of the correctness of the underlying data (IPCC, 2007).

Term	Confidence Level
very high confidence	at least 9 out of 10
high confidence	8 out of 10
medium confidence	5 out of 10
low confidence	2 out of 10
very low confidence	less than 1 out of 10

Table 5. Description of the uncertainty in the IPCC's fourth Assessment Report, where uncertainty in specific outcomes is assessed using expert judgment and statistical analysis of a body of evidence (IPCC 2007).

TERM	LIKELIHOOD RANG
virtually certain	> 99 %
very likely	> 90 %
likely	> 66 %
more likely than not	> 50 %
about as likely as not	33 to 50%
unlikely	< 33 %
very unlikely	< 10 %
extremely unlikely	< 5 %
exceptionally unlikely	< 1 %

Cognitive factors of risk perception

Cognitive factors play an important role concerning the individual determinants of risk perception. When individuals ("non-experts") are asked to estimate the probability of occurrence of certain events, it has been found that such probability estimates are frequently subject to certain systematic errors. These errors are caused by cognitive 'rules of thumb' (heuristics) which people normally use in everyday life to estimate certain events.

Whenever these heuristics are used to estimate risks, however, they are generally unsuited (Slovic et al., 1985). Experts tend to assess risks according to statistics and other "objective" technical methods whereas the estimation by non-experts (laypeople) is influenced by a variety of further factors such as values, attitudes, social influences or cultural identity (Fleischhauer et al., 2010).

A further aspect is the phenomenon of cognitive dissonance first described by Festinger (1957) and Festinger & Carlsmith (1959). Cognitive dissonance describes an uncomfortable feeling caused by holding two contradictory ideas simultaneously. In the context of flood hazards it means that information that is contradictory to the individual's value system or pattern of thoughts is not perceived at all or at least played down. Flood hazard is denied, warnings are set at nought and experts are distrusted, when property or livelihood is threatened, but the persons affected refuse to leave (Bader and Kunz, 1998). Denying the existence of flood hazard on the other hand means to avoid cognitive dissonance (Wagner and Suda, 2004).

This is a major hindrance and challenge for any risk management process as it means that a well designed communication strategy and deliberately prepared information tools may lead to nothing due to the denial of hazards and risks by individuals (Fleischhauer et al., 2010).

The management of risks (or risk governance) has become increasingly politicised and contentious. The main reasons are controversies concerning risk that are not about science versus misguided public perceptions of science, where the public needs to be educated about 'real' risks. Rather, risk controversies are disputes about who will define risk in view of existing ambiguity. Technology policy discourse is not about who is correct about assessment of danger but whose assumptions about political, social and economic conditions win in the risk assessment debate. Thus, danger is real, but risk is socially constructed. Scientific literacy and public education are important but not central to risk controversies. Emotional response by stakeholders to issues of risk is truly influenced by distrust in public risk assessment as well as management. Due to this fact, those who manage and communicate risks to the public need to start with an understanding of emotional responses towards risk (Fleischhauer et al., 2010).

After Fleischhauer et al. (2010) trust has a key role in dealing with risks and should be regarded as fundamental for risk interpretation of the public between "real" and "perceived" risks (interpretations of "risk" differ according to individual and social contexts). Public decision-making that is based only on the factual "scientific" dimension of risk leads to distrust, not taking into account the "socio-cultural" dimension, which includes how a particular risk is viewed when values and emotions are concerned (e.g. whether a risk is judged as being acceptable, tolerable or intolerable by society, is partly influenced by the way it is perceived to intrude upon the value system of society). In addition it contributes to the vulnerability of institutional settings as well as affected individuals. This causes effects on the resiliency of a community, because only those who are well informed and integrated in the process will accept the decisions made by different authorities and undertake the right choices/decisions in cases of risk.

In each single case these factors might contribute to the perception and estimation of risk in a different way. In addition, they are strongly interlinked with the more collective social-political factors mentioned before. Figure 7 summarises and relates the above described factors influencing risk perception (WBGU, 2000).

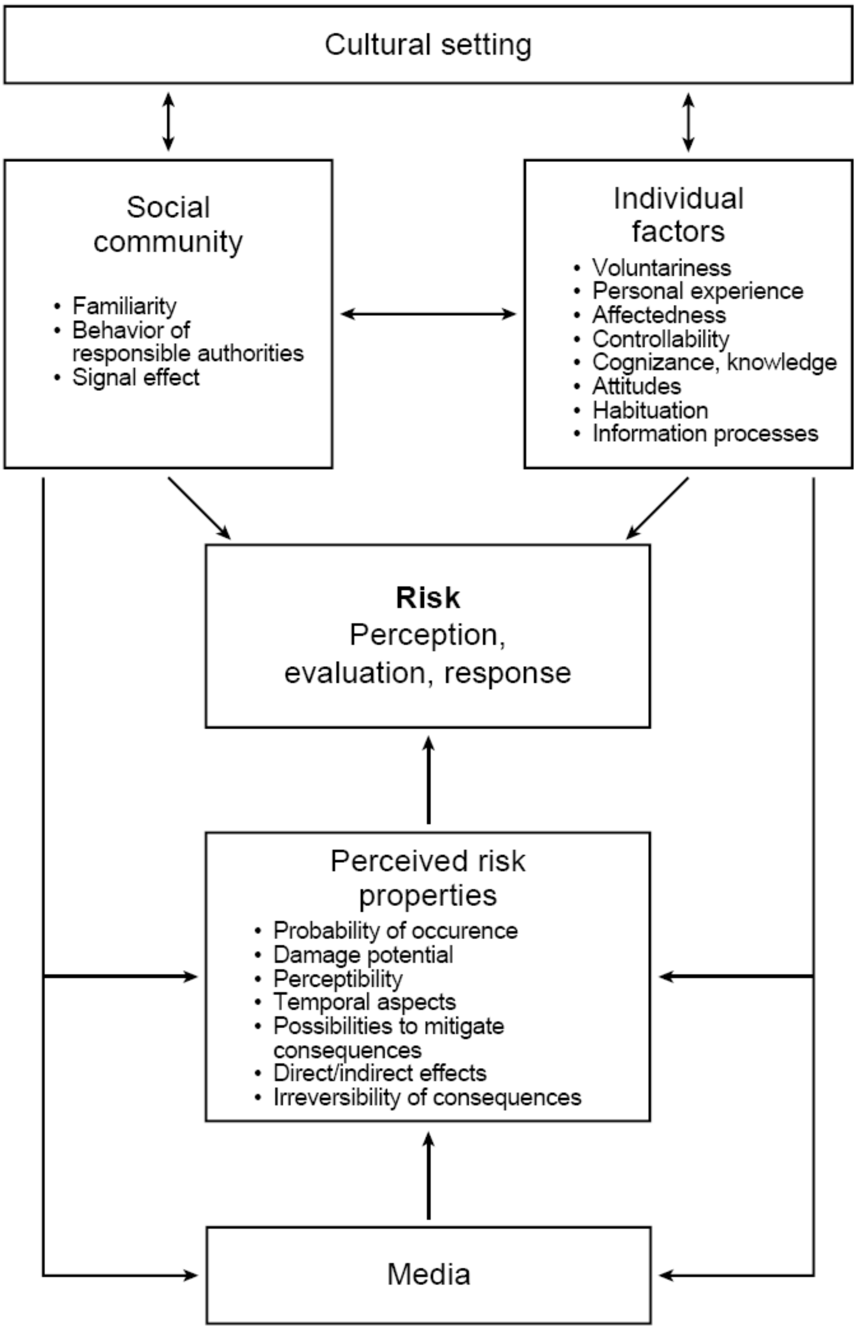

Figure 7. Factors influencing risk perception (WBGU, 2000)

Target group oriented communication

Scientists, especially from engineering studies, tend to stick to the belief that it is possible to reach everybody with one means of communication e.g. to reach all people potentially affected by climate change induced risk with one kind of flyer. From communication theory and market research we know that information material and activities have to be tailor-made to get through to the requested target groups. The target groups could be e.g. stakeholders/key persons or potentially strongly affected but hard-to-reach groups.

Risk perception is affected by attitudes and values. To plan a risk communication strategy it is necessary:

- to find out what the status of the knowledge and risk perception of the stakeholders/ the concerned population is
- to find out what values and attitudes affecting risk perception the target groups have (Fleischhauer et al., 2010).

Socio-cultural milieus

Attitudes, values and other socio-cultural features can be assigned to social groups, to "milieus". Research about social milieus is traditionally performed by market research and psychology.

Performing a detailed socio-cultural analysis of the target groups is often not foreseen or possible in publicly funded projects. But an overview on the national level what kind of target groups exist, what their attitude and values are and what kind of information material might reach them, can give valuable input to a risk communication strategy (Fleischhauer et al., 2010).

To have a basis for this discussion it is e.g. possible to use the Sinus Milieus®, developed by the market research companies INTEGRAL (Austria) and SINUS Sociovision (Germany). These Sinus Milieus® give an overview of social groups on the national level for all case studies. Integral (2009) points out that the Sinus Milieus® combine demographic characteristics such as education, profession and income with the real living environments of the people, which means with fundamental value orientations and attitudes towards working and leisure time, family and relationship, consumption and politics.

Socio-cultural, social and individual factors are decisive for the perception and the management of risks. These factors lead to major disparities of risk perception among countries, communities, certain social groups and individuals and thus to major differences in how people and societies deal with risks.

How to communicate uncertainties in climate change induced risks

When communicating uncertainties, a clear distinction has to be made:

- Who communicates with whom?
- Decide on what to communicate?

The most appropriate communication techniques are dependent on the target group and the specific goals.

What to communicate:

- Uncertainties in climate change models
- Uncertainties in the impact on specific risks
- Uncertainties in risk estimates
- Uncertainties in management procedures
- Clarity on scenarios and selecting of the most appropriate ones

How to communicate:

- Include stakeholders in the evaluation processes and ask them to find a consensus on the extra margin of safety in which they would be willing to invest in, in exchange for avoiding potentially catastrophic consequences (Höppner, 2010)

Challenges of risks problems due to uncertainty:

- Mutual understanding
- Trade-offs

3.5 Good practice examples

Good practice examples related to climate change governance can be found throughout the literature. However the link of spatial planning and climate change is not as widely known. In addition good practices can be found in many parts of the risk governance process. Here, two examples are presented: one where the necessity of an intersectoral cooperation is shown and spatially displayed, and one that relates to the protective function of forests for settlement development.

3.5.1 Intersectoral cooperation

Title: ***Map of Hydrological Degradation Potential***: Intersectoral instrument in natural hazard management, building regulations and spatial planning (Klebinder et al., 2011).

Description: In the past years several catastrophic flooding events showed that the additional water running off on sealed areas is a factor that cannot be neglected when determining the run-off of torrents and their receiving waters. In non-built-up regions only a small part of the precipitation runs-off on the surface, whereas in densely built-up areas the surface run-off is higher and faster. This leads to an unfavourable water balance and a worsening of the flooding potential. In this example an intersectoral approach is required, because the problem can only be solved when natural hazard experts, building authorities and spatial planners work hand in hand. In addition multiple actors have to be involved and their spatial development plans harmonized as for example the coordination of lower and upper river municipalities have to be considered. In this example a cross-sectoral instrument, the map of hydrological degradation potential, is introduced.

Method: First the potential degradation of the surface run-off situation due to an increase in built-up areas has to be determined by natural hazard experts. The results are subsequently visualized in regional risk maps. These, like hazard zone maps, should be an integral part of building and spatial development plans.

Spatial planning relevance: The natural hazard expert knowledge should be included in the planning stage of the development concepts. The map of hydrological degradation potential should be implemented in areas where a torrent hazard zone was delineated or restricted and referenced areas were defined. If a further development is considered, suitable details on a damage free run-off should be guaranteed. This should include the water right and building laws for the regulation of roof and surface waters (deep percolation or retention of surface water should be preferred, harmless discharge to the receiving water only in exceptional cases). Existing and planned trails and roads should be considered in the planning procedure. In principle locations with a high infiltration potential and therefore a high degradation potential should be kept free from sealing. This foresighted planning approach would minimize the need and dimensioning of compensations measures and move from mitigation towards adaptation strategies.

Up to now studies have been performed in the Salzkammergut (Upper Austria) and in central Tyrol. These applications have been discussed by the Austrian Avalanche and Torrent Control Service (WLV) and representatives of the district government. Challenges and opportunities in the future have been identified.

3.5.2 Protection by Forest Initiative (ISDW)

The initiative "Protection by Forest" (ISDW – Initiative Schutz durch Wald) is an Austrian instrument for preventive improvement of the protection effect against natural hazards.

As almost half of Austria is covered by forest (47, 2 %) and thereof 21 % are protective forests, the status and functionality of forests are very important and valuable. Furthermore recent calculations of the Federal Ministry for Agriculture, Forestry, Environment and Water Management (BMLFUW) demonstrate that without stable protective forests an additional annual investment of about 600 million € would be necessary for technical measurements for the protection against natural hazards. Technical measures are not only expensive, but also require permanent renovation and maintenance. A comparison shows: 1 € investment must be spent for permanent preservation and melioration of protective forests, whereas 100 € would be necessary for technical measurements. Against this background a new subsidy-instrument for the conservation and promotion of protective forests (so-called "Objektschutzwälder"), which protect people, settlements, infrastructure or cultivated areas from natural hazards like avalanches, debris flows, rock fall or landslides, was established.

The Federal Ministry for Agriculture, Forestry, Environment and Water Management in cooperation with experts from Forest Services of the Federal Provinces (LFD) and Forest Engineering Service in Torrent and Avalanche Control (FTD) and from the Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW) developed this programme. Within the framework of the subsidy-programme "Rural Development Ordinance (VOLE) 2007 – 2013, column 3 (Protection against natural risks)" about 6 million € per annum are additionally available for the improvement of the forest's protective functions in particularly endangered regions.

Prerequisite for potential detail-project-areas, respectively subsidy-areas, is the **district framework plan**, which is prepared on the basis of the Forest Development Plan (areas with values 3 or 2 for the protective function) by the Forest Services of the Federal Provinces or / and the District Forest Service (BFI) together with the Forest Engineering Service in Torrent and Avalanche Control. The district framework plans are revised every year and authorised by the Federal Ministry for Agriculture, Forestry, Environment and Water Management. In the district framework plan project areas are displayed within which detailed projects can be realised. They provide a concrete investigation of the respective natural risk situation as well as the planning and realisation of appropriate eligible measures. The planning is carried out by forest managers or foresters. Detailed information about the planning, implementation and subsidy of ISDW-Projects as well as the direct inspection of the district framework plan is possible in the respective District Forest Services.

By means of a simple **calculation model,** statements on the protective forest function are differentiated according to hazard types (avalanche, rock fall, landslides and surface run-off) in the colours of the traffic light (i.e. red means critical protection function). Therefore both conclusions regarding the risk potential and the protective function are stated. Consequently the necessary measures can be pointed out to enhance the structural, physical and ecological stability of the relevant protective stands, considering the respective potential natural vegetation. Not only silvicultural measures (e.g. extensive timber transport by helicopter, protection of regeneration areas, preservation of young stands, thinning), but also simple technical actions (below 30 % of the total subsidy amount) for the realisation of silvicultural measures, educational programmes and public relations are eligible for funding. Special attention is payed to the success of the realised measures without any danger by game impacts. Furthermore, aspects of climate change have to be taken into account more and more.

The focus of this programme is on the smaller and more efficient use of resources through unified and easy management of projects. Taking into account the latest international experience, the protective effect due to the specific risk potential in terms of Federal Province protective forest concepts, will be developed at district level in order to allow a better survey and assessment of forests with object protection function.

This special Austrian initiative can be seen as a good practice example for risk communication: it is not only the cooperation between different institutions but also the communication with the land owner or the forester. Everybody from the concerned parties must be involved in this process to guarantee a good detail project with its implementation for a better future of the Austrian protective forest.

D Thematic focus: Considering Climate Change Risks in the Coordination of Natural Hazard Management with Spatial Planning

1 Introduction

In most of the CLISP model regions natural hazards were identified as of concern with regard to climate change. The transition from mitigation to adaptation of risks is seen as an important task in most countries, but the role of spatial planning is not yet apparent. In order to consider climate change risks in the coordination of natural hazard management with spatial planning the following aspects have to be dealt with:

- Impact assessment of climate change on natural hazards (magnitude, frequency) and inherent uncertainties
- Intersectoral coordination, including the potential role of spatial planning in risk management
- Governance level(s) and their interaction
- Communication to / participation of stakeholders and the public

While the first aspect focuses on the hazard process and on climate change impact analysis of natural hazards, the latter three aspects deal with the governance and communication of natural hazards, especially in relation to spatial planning. Even though the target groups are decision and policy makers in hazard management, anyone dealing with natural hazards, no matter if in a climate change context or not, is encouraged to consider risk governance principles in their daily work. The wider the audience and the understanding of the benefits and limitations of risk governance, the more the acceptance and the willingness to participate will increase.

When dealing with climate change, uncertainties are inherent to the predictions and subsequently bias the impact assessment of natural hazard activity (magnitude and frequency). Irrespective of these limitations, decisions have to be made in spatial development. The question is how risk governance concepts can be applied to better manage natural hazards in an uncertain future. Generally it has to be said that uncertainties related to the assessment of alpine natural hazards outweigh the influence of climate change on these hazards. However, depending on the type of hazard and the specific local conditions, the impact of climate change on hazard potentials can be more severe than in other locations. Hazard potentials and the impact of climate change on hazard processes have to be seen in conjunction with the growth of damage potentials due to ongoing spatial development, which points to the scope for action by spatial planning.

In CLISP all model regions identified intersectoral coordination as a major contributor to successful governance of climate change risks. In the last years the need for well structured risk governance processes in managing intersectoral problems has been promoted and participation named as an integral part of any risk management procedure. Apart from the intersectoral dependencies, spatial planning involves different levels of governance and stakeholders of various interest groups; e.g. Walker et al. (2010) quote the request for more inclusion and better collaboration between stakeholders. With regard to natural hazards they point out that the relationships between different levels of governance have become increasingly important (e.g. Water Framework Directive and Floods Directive of the EU). New ways of working between local, regional and national actors should be established and elaborated. Walker et al. (2010) after Rhodes (1997) describes a situation where: "there is no longer a single sovereign authority. In its place there is: the multiplicity of actors specific to each policy area; interdependence among these social-political-administrative actors: shared goals; blurred boundaries between public, private and voluntary sectors; and multiplying and new forms of action, intervention and control. Governance is the result of interactive social-political forms of governing".

Apart from the mentioned participation in intersectoral problem solving, communication is seen as a very important aspect in all phases of the decision process, ranging from the problem framing to the successful implementation. With regard to natural hazards and their communication, several aspects have to be considered. In some countries the danger of natural hazards is acknowledged, but the concept of risk not well understood or not implemented in the instruments of hazard management. For example, in Austria hazard zoning of the Torrent and Avalanche Control Service is based on a design event with a return period of 150 years. However, for many people it is unclear that in case of a larger event they may be endangered. Up to now there is a lack of communicating residual risks. In Austria hazard zone planning under the forest law has been in place since 1975, but its consideration is still not legally binding in spatial planning in all states. Clear boundaries of hazard zones (e.g. yellow, red) are delineated by natural hazard experts, but in some provincial states they are not implemented effectively in the spatial planning laws. One reason is that often the reference to the hazard zone maps is not made explicitly, another reason is that the consequences for building land allocations are either not legally binding or defined too imprecise. It also seems necessary to improve the communication of the residual risks, but a participation in the hazard zoning process does not seem appropriate. The communication and documentation of past events is also important, because they are a good indicator for the danger. In the past events were communicated from generation to generation, but due to an increased mobility of the population nowadays, this information is often lost.

In **Section D 2** of this thematic focus, existing risk management procedures are described with regard to limitations due to climate change on transnational level, i.e. without making reference to particular countries. In addition recommendations are given on how to deal with upcoming challenges. In the future, existing decision making structures have to be adapted to meet changing framework conditions. In **Section D 3** a decision-supporting concept is introduced, which intends to help in different parts of the decision process. That tool, the $CC_{mountain}$Fitness Guidance, aims at the identification of climate change impacts on natural hazard processes, i.e. an estimation of the sensitivity of hazards processes to changes in climatic stimuli.

2 Recommendations on how to deal with climate change in natural hazard management, including spatial planning

Based on existing legal frameworks and spatial planning instruments the question is how to deal with climate change in natural hazard management. In the last years this issue was widely discussed by natural hazard as well as spatial planning experts. In the CLISP project most of the spatial planners identified integration of climate change risks in instruments of natural hazard management as a task of relevant sector policies at the national level. In that perspective, methods and instruments of hazard management that take account of climate change risks have to be provided as a planning basis before they can be implemented by spatial planning and on lower levels of governance. For a majority of municipalities as well as a significant number of politicians in Austria, the acceptance of hazard mapping required considerable time period. There are concerns that inclusion of climate change in the assessment and mapping methods could seriously undermine the acceptance gained during the last decades. In addition, many stakeholders do not see climate change as their foremost concern, but as an issue among others.

The **main weaknesses** identified within CLISP in the currently existing risk management include:

- Uncertainty regarding climate change scenarios and the impacts of climate change on hazard potentials.
- Small-scale regional differences in climate change impacts impede the formulation of general recommendations. Furthermore climate change is often not the main concern.
- Implementation weaknesses, especially hesitant implementation of hazard zone maps in spatial planning. E.g., in some countries or parts of countries hazard zone mapping is not legally effective in a binding way in spatial planning laws.
- There are too many “creative” ways (exceptional allowances for allocating building land) to overrule building restrictions in hazard zones in order to avoid constraints to settlement development (e.g. in Austria it is possible to fill in building gaps within settlement structures in the red zone).
- Hazard mapping (e.g. in Austria) is only performed for existing settlement areas, whereas important areas for infrastructure or future development areas are not incorporated.
- In most countries hazard mapping is dominant and the move to risk management is not yet performed.

- Non-structural measures are not considered as being equal to technical measures despite of higher cost effectiveness.
- Differences between adaptation and mitigation of natural hazard risks are not apparent.
- Deficits in the cooperation and communication between various levels of governance, various sectors and with the public due to a lack of cooperation between spatial planning and sector planning on natural hazards.

Recommendations identified within CLISP include:

- Risk planning for settlement areas in addition to hazard mapping.
- Prioritisation of passive, non-structural flood protections over structural protection measures. Designating areas for flood retention and keeping them free of building land allocations.
- Checking climate change fitness of spatial planning instruments (cf. CLISP WP5).
- Adaptation of the hazard assessment basis by including uncertainty aspects in hazard zone mapping reflecting climate change or by considering at least higher volatility concerning extreme weather events and the probability of their occurrence.
- Strengthening public participation regarding regulatory regimes in spatial planning processes.
- Improving the definition of residual risks and their communication.
- Clearly communicating uncertainties and residual risks (not limited to climate change, but also comprising more dominant aspects such as land use).
- Preventing soil sealing or reducing the growth rate of sealing through improving the effectiveness of spatial planning, in particular in cases where a sustainable compensation measure for sealed soil cannot be applied (e.g. by way of retention areas).
- Facilitating re-allocation of building land in hazard zones.
- Accounting for rock fall and smaller landslides in hazard mapping.
- Legal incorporation of hazard zones in spatial planning and building laws, where not already done.
- Fostering an integral risk governance structure in endangered areas.
- Considering protection forest issues in greater detail, e.g. by better coordination of protection forest planning and management with spatial planning and hazard experts.
- Promoting regional cooperation in flood protection – improving cooperation between up-stream and down-stream municipalities and providing support by the regional or state planning level.
- Strengthening the regional planning level to foster regional cooperation where applicable, instead of favouring island solutions on local level (e.g. in flood prevention or runoff mitigation).
- Strengthening regulations for land use in the follow-up of natural catastrophes (re-construction, etc.).
- Consider compensation options for the restriction of land use, e.g. in agricultural areas.

3 Decision-support tool for the practitioner

3.1 $CC_{MOUNTAIN}$Fitness Guidance

3.1.1 Introduction

The requirements in natural hazard risk management procedures are becoming higher due to climate change. In view of the heterogeneity of stakeholders, levels of governance and the sectors involved in modern risk governance frameworks, static planning instruments are not feasible anymore. A more dynamic planning procedure, also incorporating regional development strategies, seems more promising to meet the challenges of climate change. In order to facilitate an easy implementation of new ideas in existing decision making structures, decision tools are indispensible. $CC_{mountain}$Fitness Guidance developed by Karl Kleemayr (BFW) offers practice-related decision support for the identification of climate change impacts on natural hazard processes, i.e. an estimation of the sensitivity of hazard processes to changes in climatic stimuli. The tool will give guidance on how to analyze the status quo of natural hazard processes within a region, their sensitivity to climate change, and the related uncertainties. The main user groups of the tool are natural hazard experts (mainly public authorities), whereas the results will be important for all spatial planning decision makers, like mayors or planners at the municipality level.

The $CC_{mountain}$Fitness Guidance complements the results of CLISP WP5 in the regard that its intention is rather on the local implementation than on specific spatial planning instruments. In contrast to the vulnerability analysis in WP4, which focuses on the regional level, here the focus is on process level.

In **Section 3.1.4** the $CC_{mountain}$Fitness Guidance will be applied to assess the climate change impacts in the case study municipality Gasen (Styria/Austria).

Objectives of $CC_{mountain}$Fitness Guidance

The CC-Fitness Guidance strongly concentrates on climate change induced spatial planning problems with special focus on mountain regions.

The objective of the $CC_{mountain}$Fitness guidance is to support decision making authorities:

- to check spatial planning instruments in mountain regions – both instruments that are in force as well as during a revision process - whether the **most important climate, society and vulnerability factors** have been **included in the decision development process;**
- to distinctively address the most **sensitive and vulnerable issues;** and
- to work out adaptation strategies fostering the resilience capacity.

Furthermore the $CC_{mountain}$Fitness guidance aims at:

- increasing the awareness of climate change impacts on mountain societies;
- increasing the sensitivity for adaptation deficits; and
- increasing the preparedness for new and alternative counter measures and risk management strategies.

3.1.2 Method

The applied method is qualitative to semi-quantitative. The $CC_{mountain}$Fitness concept comprises four assessment steps, which are shown in Figure 8. It should be noted that the risk concept as established in the natural hazard and disaster risk assessment community differs from the vulnerability concept as applied in the climate change community. The method presented here is an approach to integrate climate change in the hazard and risk assessment process as it is common to natural hazard experts.

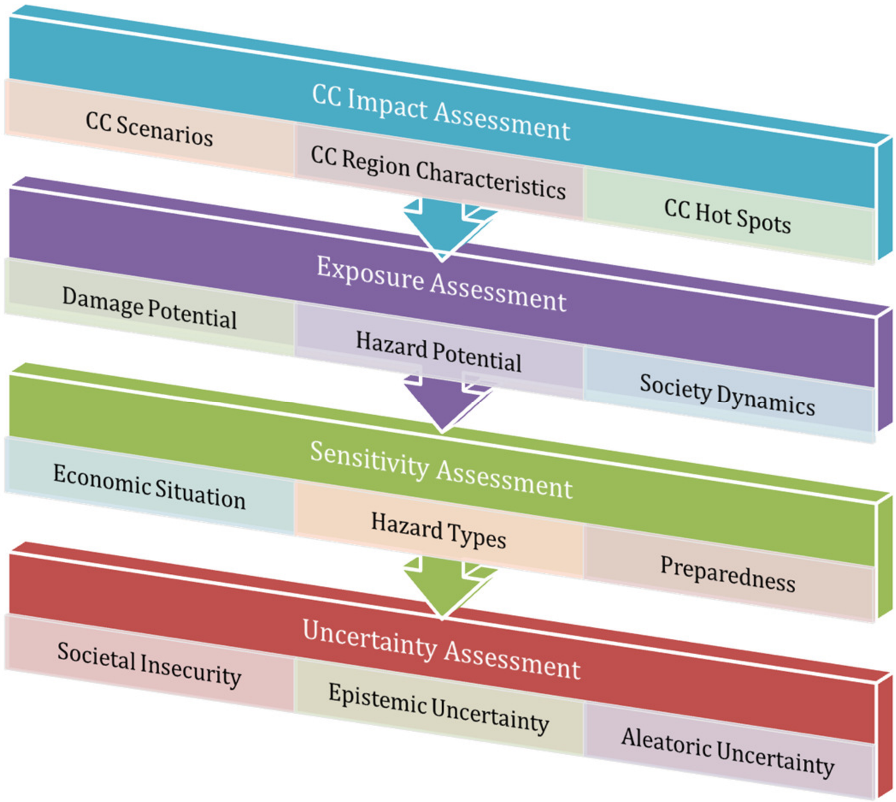

Figure 8. Elements of $CC_{mountain}$Fitness concept

1. Climate change assessment

Climate change – models, data and results

For the vulnerability analysis in CLISP WP4, climate change scenarios for each model region were identified. The used climate models included: Global Climate Models (GCM), i.e. ECHAMS, HadCm3, ARPEGE and Regional Climate Models (RCM) REMO, CLM, RegCM3, ALADIN. The selection depended on the availability over all participating Alpine Space countries. Consequently, higher resolution models available in some countries could not be used. For the application of the $CC_{mountain}$Fitness Guidance, especially for the climate change impact analysis regarding natural hazards, it is important to work with more local data. In Austria, data in a 10 km grid are available from the project reclip:more and are further used in this study. For details on other models please refer to the WP4 synthesis report.

The global average temperature will rise and the precipitation patterns around the world are likely to change in the next decades. For further impact studies more detailed data about the changing climate on a regional scale are needed. The following three projects, HISTALP, PRUDENCE and reclip:more provide such data for the Alps.

The reclip: more (research for climate protection: model run evaluation) project offers high resolution climate change scenarios for the Greater Alpine Region (Loibl et al. 2007). The scenarios represent the changes in the mean temperatures and precipitation values for the period 2041-2050, relative to 1981-1990. The spatial resolution of the model grid is 10 km. Simulations have been done with two different RCMs (MM5, ALADIN) driven with data from one GCM (ECHAM5). The GCM simulations are based on the “business as usual” scenario IS92a according to the IPCC report 2002 (IPCC 2000). The IPCC IS92a scenario specifies equivalent Green House Gas (GHG) concentrations and sulphate aerosol loadings from 1850 to 2100. Climate change data are available for a 10 km grid and seven sub-regions. Further information is available on the homepage http://foresight.ait.ac.at/SE/projects/reclip/.

Table 6. Projected seasonal trends of changes in temperature (TEMP) and precipitation (PREC) per decade for the Alps and for the case study municipality Gasen (Loibl et al. 2007).

Model (Region/Season) Period	**TEMP [°C/decade]**	**PREC [%/decade]**
reclip:more (Alps/winter) 2041-2050 vs. 1981-1990	0.32	1.3
reclip:more (Alps/spring) 2041-2050 vs. 1981-1990	0.37	0.2
reclip:more (Alps/summer) 2041-2050 vs. 1981-1990	0.38	-2.1
reclip:more (Alps/autumn) 2041-2050 vs. 1981-1990	0.45	-2.3
reclip:more-MM5 (Gasen/winter) 2041-2050 vs. 1981-1990	0.33 to 0.42	2,5 to 3,3
reclip:more-MM5 (Gasen/spring) 2041-2050 vs. 1981-1990	0.42 to 0.5	-0.8 to 0.8
reclip:more-MM5 (Gasen/summer) 2041-2050 vs. 1981-1990	0.33 to 0.42	-0.8 to 0.8
reclip:more-MM5 (Gasen/autumn) 2041-2050 vs. 1981-1990	0.42 to 0.5	-4,2 to -5
reclip:more-ALADIN (Gasen/winter) 2041-2050 vs. 1981-1990	0,17 to 0,25	4,2 to 5
reclip:more- ALADIN (Gasen/spring) 2041-2050 vs. 1981-1990	0.33 to 0.42	-0.8 to 0.8
reclip:more- ALADIN (Gasen/summer) 2041-2050 vs. 1981-1990	0.42 to 0.5	0,8 to 1,7
reclip:more- ALADIN (Gasen/autumn) 2041-2050 vs. 1981-1990	0.33 to 0.42	-3,3 to -4,2

Temperature and precipitation changes according to the reclip:more dataset for the Alps

For the Alps and especially for Austria, regional climate data from the reclip:more project are available for the period between 2041-2050 and are compared to the period between 1981-1990 (Loibl et al. 2007). Projected temperature increases in the Alpine region ranges from 1.9°C (0.32°C per decade) in winter, 2.2°C (0.37°C per decade) in spring, 2.3°C (0.38°C per decade) in summer and 2.7°C (0.45°C per decade) in autumn (Loibl et al. 2007, Table 6). The temperature change pattern shows a distinctive trend toward larger increases at higher altitudes. In this case just a rough estimation of the uncertainties can be given, because in the reclip:more project only three regional simulations have been performed, which are all based on the same global simulation. The comparison of the three different RCM shows a range of ±0.21°C. According to Déqué et al. (2007) the contribution of the RCM simulation failure to the overall failure in the Alpine region is 20 to 25 %. Hence, the uncertainties respectively the range of the projected temperature changes in the reclip:more simulations is about ±1.25°C (Gobiet 2010). This means that at least the direction of the temperature trend is highly significant.

The reclip:more simulations predict an increase in precipitation of 7.9 % (1.3 % per decade) for winter and of 1.2 % (0.2 % per decade) for spring. However, for summer and autumn decreases in the precipitation values are projected by 12.3 % (2.1 % per decade) and 13.9 % (2.3 % per decade) (Loibl et al. 2007, Table 6). The range of the three RCM used in reclip:more is ±5%. According to Déqué et al. (2007) the failure of the RCM contributes 30 to 50 % to the overall failure of the precipitation changes in the Alpine region. Hence the uncertainty respectively the range in the predicted precipitation changes is ±10 to ±15 % (Gobiet 2010). This means that neither the values nor the directions of the projected precipitation changes are significant.

Because the reclip:more simulations apply to the middle of the 21st century and the PRUDENCE simulations to the end of the 21st century, they are not directly comparable. Basically both simulations show the same characteristics: Comparable values of temperature increase, with the highest changes projected for spring and autumn. Decreasing precipitation values in summer and autumn and increasing values in winter. However, the values named here are averages over the whole Alpine region and can vary significantly from region to region. For example, the predicted precipitation patterns for the Alps show increasing values north of the main ridge of the Alps and decreasing values in the South.

Temperature and precipitation changes according to the reclip:more dataset for Austria

The reclip:more project offers detailed information about the future climate changes for Austria. The average annual temperature increase will be 2 to 2.5°C (0.33 to 0.42°C per decade) and along the main ridge of the Alps even higher (Loibl et al. 2009). The annual precipitation amounts will generally decrease in the South and East of Austria, while in the North and West of the main ridge of the Alps the annual precipitation amount will slightly increase (Loibl et al. 2009). Additionally the regional changes in temperature and precipitation for

Austria are given for the different seasons (Loibl et al. 2009). For winter the projected temperature increases range from 1.3 to 1.8°C (0.22 to 0.3 per decade) in the North and East of Austria and from 1.5 to 2.0°C (0.25 to 0.33°C per decade) in the South and the West. In spring the temperatures in the western part of Austria and in the whole Alpine region will increase by 2 to 3°C (0.33 to 0.5°C per decade), whereas in the rest of Austria the predicted values are between 1.8 and 2.5°C (0.3 to 0.42°C per decade). For the summer a general temperature increase of 2 to 2.5°C (0.33 to 0.42°C per decade) is projected. Again the increase in the western part of Austria and in the Alpine region will be higher with values between 2.5 and 3°C (0.42 to 0.5°C per decade). In autumn temperatures are predicted to rise between 2.3 and 3°C (0.38 to 0.5°C per decade) in the West of Austria, whereas this time the increase for the rest of Austria is slightly higher 2.5 to 3°C (0.42 to 0.5°C per decade).

For winter, increasing precipitation values from 15 % to 30 % (2.5 to 5 % per decade) are projected for Austria. In the western part of Austria the precipitation will increase by 10 % (1.7 % per decade), whereas in other parts of Austria a decrease of up to 15 % (2.5 % per decade) is predicted. In spring the precipitation values will increase by 5 to 25 % (0.8 to 4.2 % per decade) over the main ridge of the Alps. However, in the East a decrease of 15 % (2.5 % per decade) is projected. In summer a wide range of changes, from -20 to +15 % (-3.3 to +2.5 % per decade) in the Alps and in the East even -15 to +30% (-2.5 to +5 % per decade) are predicted. For autumn the precipitation values over the main ridge of the Alps will stay constant, whereas for the North and East decreases from 25 to 35 % (4.2 to +5.8 % per decade) and in the West and South increases around 15 % (2.5 % per decade) are projected.

Changes in extreme events according to the reclip:more dataset (Austria)

Besides the projected changes of the temperature and precipitation the changes in the number of extreme events can also be derived from the reclip:more data (Loibl et al. 2009). The average number of frost-days (Tmin < 0°C) will decrease up to 50 % in Austria, whereas the number of summer-days (Tmax > 25°C) will double until 2050. The average number of heat-days (Tmax > 30°C) will quadruple in the East of Austria and will become a common phenomenon in the rest of Austria. Heavy precipitation events with more than 50 mm precipitation per day will increase on average by one to two events per year, along the main ridge of the Alps even by two to three events. Due to a decreasing tendency of the precipitation values, it must be assumed that in the future precipitation events in general will become less frequent, but more intense.

2. Exposure assessment for natural hazards

The aim of the exposure assessment procedure is

- to have a clear idea of vulnerability
- to know what the most critical objects and sectors are now and in the future assuming an ongoing climate change
- to know where adaptation of land use strategies is required most

The exposure assessment basically consists of three steps:

- Assessing the hazard potential: all dangerous processes have to be listed and evaluated. Typically, the processes concerned are torrents, mud flows, landslides, erosion processes, avalanches and rock-fall.
- Assessing the damage potential: values of all endangered objects,
- Assessing the expected society dynamics: the societal dynamics – with and without climate change – strongly influence the exposure development.

Hazard Potential Assessment

For all possible hazards in a given regions the following information should be assessed[1]:

- Size of the red zone, number of buildings in the red zone
- Size of yellow zone (blue zone), number of buildings in it
- Number of buildings bordering the yellow zone (e.g. within 100m of yellow zone)
- Amount of hazardous events in the last 100 years (chronicle, hazard cadaster)
- Summarised area of protection forests
- Area of protection forests directly protecting objects like buildings or infrastructure
- Percentage of built-up area

Damage Potential Assessment

- Amount of damages in the last 100 years
- Amount of protection measures in the last 100 years
- Percentage of settlement, infrastructure and industry area in the outlined hazard zones
- Value of buildings in the red zone
- Value of buildings in yellow zone
- Value of building bordering the yellow zone

Dynamics Assessment

- Population growth in the community
- Economic dynamics of community (e.g. in terms of over all tax development)
- Development of single sectors (tourism, industry, ...)
- Migration trend
- Availability of free land
- Drinking water resources

Adjacent questions which should be taken into account

- Are there already problems in protection forests (biotic or abiotic damages)?
- Are there already existing land use conflicts?

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[1] In Austria, the following categories of hazard zones are designated in the hazard zone maps of the Torrent and Avalanche Control Service:

- *Red Hazard Zones* (mandatory): Areas threatened by torrents and avalanches that are not suitable to be permanently used for settlement and transport activities. The relevant design event for designation of the Red Zones is the 150 year return interval of disaster events.
- *Yellow Hazard Zones* (mandatory): All other areas threatened by torrents and avalanches whose permanent land use for settlement and transport activities is restricted by the exposure.
- *Blue Reservation Areas* (mandatory): Areas that are earmarked for structural and other active protection measures and shall thus be kept free from other building activites or may require special land use management.
- *Brown Index Areas* (optional): Areas where threats by other natural hazard processes than torrents and avalanches (e.g. rockfall) are indicated.
- *Violet Index Areas* (optional): Areas whose present state must be preserved in order to ensure protective functions.

- How high is the energy autarky of the region?
- Sustainability of tourism – overuse of natural resources, impacted landscape scenery?
- Economic sensitivity of community: multi-sectoral or single-sectoral economy?

General suggestions for further development

- The hazard potential has to be defined not only for the reference event. In reality the hazard is a more or less stochastic continuous process ("more or less" dangerous and not "danger – no danger"). All event probabilities – from frequent to very rare - have to be outlined
- Different types of control measures i) technical – permanent ii) temporary and iii) planning have to be assessed taking the different overall costs and efficiency into account (development of support tools like Riskplan)

3. Sensitivity assessment

The sensitivity assessment process evaluates three different types of sensitivity.

Hazard sensitivity

Different watersheds, avalanche tracks or rock slopes react differently on increasing temperature, precipitation or storms. Even though a standardised assessment is difficult due to fact that all natural hazards are complex systems, simple generalised rules can be found. The main question is "assuming climate change what system properties favour the generation of i) more frequent or ii) bigger or iii) more frequent AND bigger hazardous events?"

This has to be listed for all natural hazard types.

1) Size of a homogenous release area (->magnitude)

2) Slope of the release area (-> frequency)

3) Slope of track (-> magnitude)

Economic sensitivity

The economic situation of a community strongly influences the adaptive capacity. The assessment hypotheses is that mountain communities with

- ulti-sectoral income,
- Low migration trend,
- Sustainable tourism,
- High energy autarky,
- …

have lower vulnerability because of higher adaptive capacity.

Preparedness

Vulnerability is generally lower if people are prepared. An adequate "prophylactic" awareness-raising and communication process is sometimes difficult to carry out but one of the most efficient ways to reduce vulnerability. For mountain region communities the following topics are essential:

- Do contingency plans exists?
- Have inhabitants been informed and are they aware of possible negative developments?
- Have inhabitants have been informed about possible personal and individual adaptive measures?
- Do inter-communal communication and control processes exist?

4. Uncertainty assessment

The uncertainty assessment procedure consists of three steps:

Societal insecurity

There are different reasons for insecure feeling of the society:

- No information about possible negative developments
- No information of control strategies
- Uncoordinated information of media
- Negative experiences in the past
- ....

For an efficient implementation of adaptation strategies with acceptance and high willingness of stakeholders and people affected to contribute, it is essential to inform people and give them a feeling of safety and capability to handle the future.

Empirical uncertainty:

If a hazardous process cannot be described in exact words or with exact models, empirical uncertainty remains. This uncertainty is necessary to be described if the derived activities impact the endangered people in a negative way. Empirical uncertainty is high if:

- The hazardous process is very difficult to describe (e.g. the wateshed has a complex geomorphology hampering a precise run-off calculation)
- Many hazardous process are overlaid
- The efficiency of control measures is not clear
- ....

Aleatorical uncertainty:

Aleatoric uncertainty arises if the "random character" of a process is negatively high. All natural hazards are stochastic, but watersheds and avalanche tracks with higher frequency give a feeling of lower aleatorical uncertainty. If observations are rare, uncertainty is high for the "unlikely event" to happen nevertheless.

Where / what are the most vulnerable buildings and sectors?

- Update of land-use hazard maps
- Adaptation of contingency plans
- Additional retention areas
- Additional safety areas
- Awareness-raising actions
- Protection forests are under observation
- Optimised control measures (technical, temporary, planning)
- Adapted tourism strategy
- Development of sealed areas is under observation

3.1.3 Application in CLISP: Study area Gasen

1. Climate change assessment

Temperature and precipitation changes according to the reclip:more dataset for Gasen

Table 7 shows the data for the test site Gasen, corresponding to the simulations of the RCM MM5 and ALADIN. The test side Gasen is located in the north-western part of Styria/Austria. The greatest temperature increase is projected by the MM5 model for spring and autumn and by the ALADIN model for summer and not for autumn. With regard to the projected precipitation values, Gasen shows a very similar trend than that of the Alps or Austria. The results of both RCM show that precipitation is projected to increase in winter and decrease in autumn. Especially remarkable is the high projected increase in winter and lower projected decrease in autumn in the simulations with ALADIN, compared with those from MM5. In spring no significant changes are projected by MM5 and ALADIN. ALADIN shows increasing precipitation values in summer, whereas the results of the MM5 simulation show no significant trend for this season. In the case of MM5 the annual precipitation is projected to decrease, whereas the results of the ALADIN simulation point at increasing annual precipitation for the region.

In comparison to the general climate trend in Austria the community of Gasen therefore is exposed to climate change in an “average” way: a tendency to drought events and a slight tendency to more precipitation in winter.

Table 7. Projected seasonal trends of changes in temperature (TEMP) and precipitation (PREC) per decade for the case study municipality Gasen

Model (Region/Season) Period	**TEMP [°C/decade]**	**PREC [%/decade]**
reclip:more-MM5 (Gasen/winter) 2041-2050 vs. 1981-1990	0.33 to 0.42	2,5 to 3,3
reclip:more-MM5 (Gasen/spring) 2041-2050 vs. 1981-1990	0.42 to 0.5	-0.8 to 0.8
reclip:more-MM5 (Gasen/summer) 2041-2050 vs. 1981-1990	0.33 to 0.42	-0.8 to 0.8
reclip:more-MM5 (Gasen/autumn) 2041-2050 vs. 1981-1990	0.42 to 0.5	-4,2 to -5
reclip:more-ALADIN (Gasen/winter) 2041-2050 vs. 1981-1990	0,17 to 0,25	4,2 to 5
reclip:more- ALADIN (Gasen/spring) 2041-2050 vs. 1981-1990	0.33 to 0.42	-0.8 to 0.8
reclip:more- ALADIN (Gasen/summer) 2041-2050 vs. 1981-1990	0.42 to 0.5	0,8 to 1,7
reclip:more- ALADIN (Gasen/autumn) 2041-2050 vs. 1981-1990	0.33 to 0.42	-3,3 to -4,2

2. Exposure Assessment

The rural community of Gasen is located in the eastern part of Styria (around 60km north-east from Graz) in the range of the “Fischbacher Alps”, a low mountain range mostly covered by forests and alpine grazing areas. Approximately 950 inhabitants populate an area of 34 km² resulting in a comparably low population density of about 28 inhabitants/km² (on average 100people/km² for Austria).

The community of Gasen attracted special attention from scientists and professionals in the field of natural hazards in 2005 when a series of landslides (300) occurred after a sustained precipitation period.

Analysis of present situation for the model community

The following figures and tables reflect the present state of the exposure situation for the model community of Gasen. The analysis is based on information obtained from the following data sources:

- land use plan
- hazard maps
- digital elevation model with 10m raster resolution
- orthophotos
- road network information

Basic information

Due to the steep, mountainous topography, concentrated settlement areas are restricted to the valley bottom and gentle hill slopes (see Figure 9 and Figure 10) which leaves only 3.76% of the total community area suitable for settlement.

Table 8. Basic data for the model community Gasen

Area	33.95 km²
Area suitable for settlement	1.276 km²
Percentage of area suitable for settlement	3,76 %
Range of elevation	690m – 1470m
Inhabitants	ca. 950
Number of torrents	24

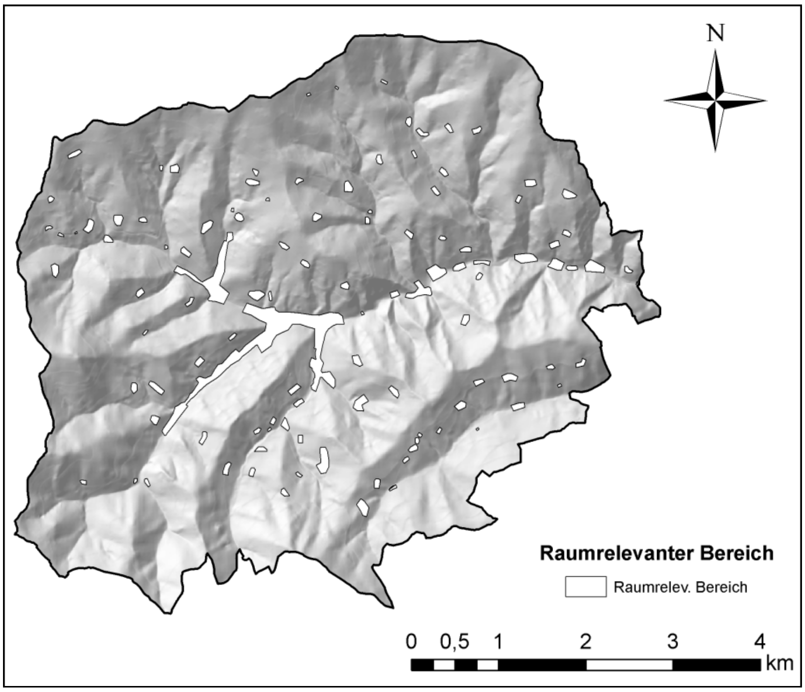

Figure 9. Overview of the area suitable for settlement (depicted in white) for the model community, which accounts for 3.76 % of the total community area.

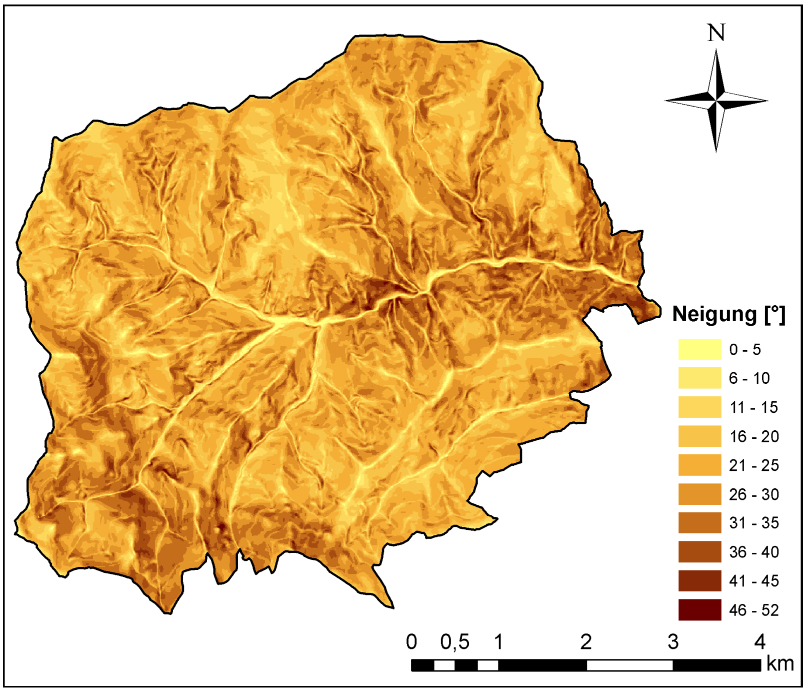

Figure 10. Inclination map for the model community – the valley is bottom mainly used for settlements(see fig. 9) and is bordered by relatively steep slopes prone to mass movements

Hazard Zones

Relevant hazard zones for Gasen include red and yellow hazard zones for torrents, yellow hazard zones for avalanches and brown hazard zones for landslide processes (Table 9; Figure 11). With respect to brown hazard zones, Gasen can be considered a showcase example in Austria since landslide mapping has been conducted for no other community on a comparable level of detail.

Table 9. Hazard zones for the model community considering areas affected by more than one process in km2

zone	**area**
red hazard zone for torrents AND brown hazard zone	15926 m²
yellow hazard zone for torrents AND brown hazard zone	11924 m²
yellow hazard zone for avalanches AND brown hazard zone	6082 m²
red zone for torrents	91557 m²
yellow zone for torrents	82330 m²
yellow zone for avalanches	14601 m²
brown zone	1199969 m²
total area in hazard zones	**1.42km²**

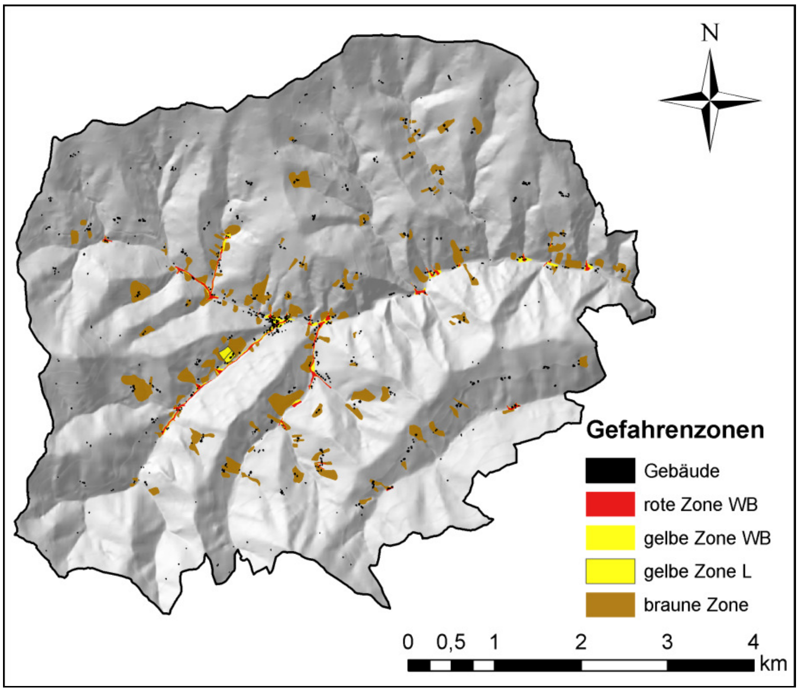

Figure 11. Hazard zones for the model community - buildings are indicated by the black signature

Land use

Table 10. Designated areas for settlement, industry, business and traffic for the model community

type	**area**
settlement area	0.0109 km²
industrial and business area	0.0237 km²
transport area	1.0264 km²

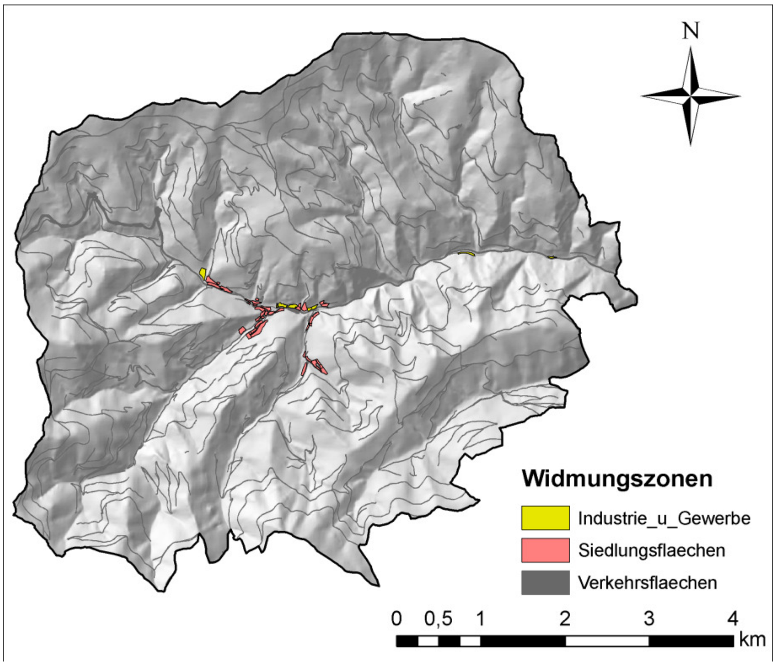

Figure 12. Designated areas for industry and business (yellow), settlement (pink) and transport areas (grey) for the model community

Buildings in endangered zones

The number of buildings in identified hazard zones can serve as a measure indicating the exposure of a given community to natural hazard processes. The figures shown in Table 11 indicate that in the model community around 31 % of all buildings are located in hazard zones. For industrial buildings the percentage is considerably higher with 68.75 %.

Table 11. Number of buildings in hazard zones for the model community of Gasen

hazard zone	area [m²]	number of industrial buildings in zone	number of other buildings in zone
red zone torrents	91557	5	31
yellow zone torrents	82330	2	56
yellow zone avalanches	14601	0	2
red torrents and brown	15926	0	6
yellow torrents and brown	11924	0	3
yellow avalanche and brown	6082	0	3
brown	1199969	4	107
no hazard zone		5	479
totals:	**1422390**	16	687
number of buildings in hazard zones:		11	208
% of buildings in hazard zones		68.75	30.28

Forest

More than half of the community area of Gasen is covered by forest stands. About one third of the forest area covers terrain steeper than 30° and can thus be classified as stands with mainly protective functionality (Table 12; Figure 13).

Table 12. Area covered by forests in % of the total area of the community

category	area
Total area covered by forests	19.31 km²
% of forest areas compared	56.9 %
Forest covering areas steeper than 30°	6.55 km²
% of forest steeper than 30°	33.9 %
% of forest steeper than 30°	19.3 %

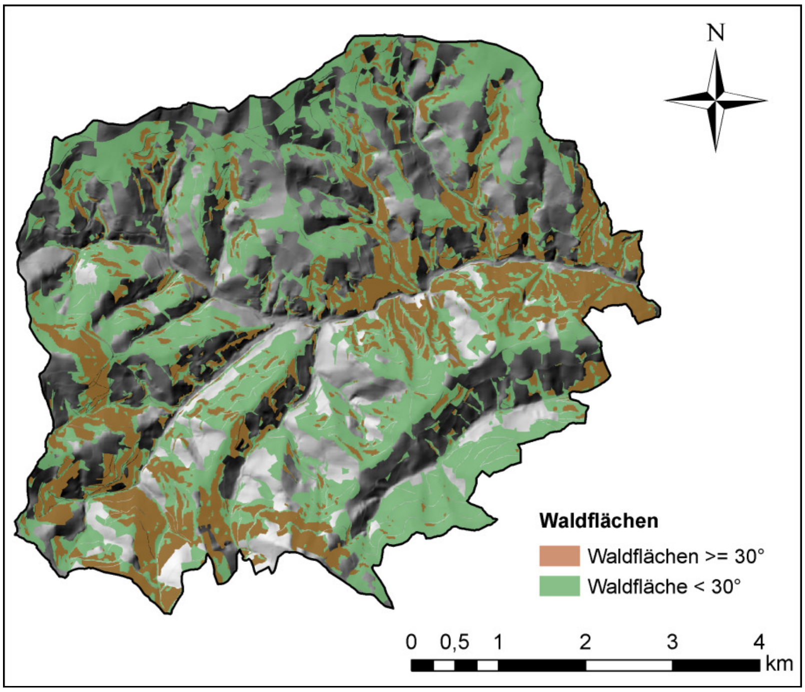

Figure 13. Areas covered by forest – the brown signature indicates forest stands on terrain inclined 30° or steeper

Road infrastructure in hazard zones

The total length of road infrastructure for the model community accounts for approximately 86.7 km of which around 48.6 km account for private roads and 18.2 km and 7.1 km for community roads and state roads respectively. Table 13 indicates the lengths of road stretches affected by hazard zones.

Table 13. Road infrastructure affected by hazard zones – the last column indicates the percentage of total roads located in the respective hazard zones

hazard zone	length affected	private roads	community roads	state roads	% of total
red zone torrents	2161 m	481 m	838 m	842 m	2.49
yellow zone torrents	3173 m	614 m	1586 m	973 m	3.66
yellow zone avalanches	103 m	103 m	0 m	0 m	0.12
red torrents and brown	240 m	146 m	0 m	94 m	0.28
yellow torrents and brown	283 m	159 m	110 m	14 m	0.33
yellow avalanche and brown	39 m	39 m	0 m	0 m	0.05
brown	6774 m	5891 m	780 m	104 m	7.81
within zones	12774 m	7433 m	3314 m	2027 m	14.74
outside zones	73915 m	48630 m	18186 m	7099 m	85.6
Total:	**86690 m**	**56064 m**	**21500 m**	**9126 m**	**100**

3. Sensitivity Assessment

Hazard Sensitivity

In 2005 about 300 landslide events endangered the community of Gasen. 30 landslides with a volume of > 1000 m³ caused significant damage. Five of these landslides had already been observed earlier, but past event cadastres give no indication to a catastrophic event comparable to that of 2005. Geology and geomorphology clearly show a general disposition for landslides and the community is generally aware of these problems. However, most of the hazardous events in the past have included torrents. Therefore technical control measures with the respective intensity focused on the control of flood damages. Concerning the expected changes due to climate change, the community of Gasen has – in relation to other Austrian mountain communities – a low sensitivity with respect to torrents and floods. Concerning landslides, the sensitivity lies above average and developing a continuous monitoring of the landslide prone areas is necessary.

Economic sensitivity

The population of Gasen (~1000 inhabitants) has remained constant for the last 15 years. The amount of families has not changed much since this time, however, the number of persons per family has decreased, which is typical for rural areas. The community income is based on two sectors: steel engineering and carpentry enterprises on the one hand and tourism on the other (all of which are medium-sized and in economically stable situations). Beside these companies the typical community infrastructure (grocery, bank, kindergarten, etc.) exists.

In Gasen one of the first bioenergy powerstations of Styria has been running for the last 20 years, fuelled only by wood of the community. 75% of Gasen's warm water is supplied by this powerstation. The springs within the community area easily yield its requirements of drinking water.

Thus, it can be expected that the economic stability and the quality of life in the community is quite high, easily buffering some negative developments due to climate change. The economic sensitivity therefore is low.

Preparedness

For the community of Gasen both a hazard map and a contingency map exist. After the events of 2005 the awareness of torrent and landslide problems increased not only for the decision making authorities but also the population in general. In numerous public discussions the issues have been discussed with the inhabitants. The events of 2005 also lead to an integration of "landslide prone areas" in the hazard map, land use map and partly also in the contingency plan. Due to the fact, that the neighbouring communities like Haslau also have been heavily impacted, the inter-communal communication is relatively high. Thus also the preparedness of the community is - at least currently – very high with respect to possible natural hazards and damage potentials. Under guidance of the recent mayor, a similar preparedness can also be expected for the next years.

4. Uncertainty Assessment

Societal insecurity

With the catastrophic events of 2005 and the professional communication process mainly guided by the mayor the problems, fatalities and damages have been discussed very openly and transparently. The people of Gasen are aware of the problems, but are not insecure. Furthermore, during the events there have been nearly no cases of bad media information, mutual accusation or other conflict issues. This can be ascribed to the good crisis management of the community, the district and the torrent and avalanche control service during and shortly after the events (although there have been significant damages and fatalities).

The community of Gasen therefore is aware of the problems now and in the future, but they do not feel insecure due to the positive crisis management and the adaptation measures.

Empirical uncertainty

In Gasen only two natural hazard types are relevant: Torrents (floods and debris flows) and landslides. There are no avalanche or rock fall problems and also other risks e.g. from the steel enterprise are very low. Torrents and landslides are both strongly dependent on weather conditions in frequency and intensity and thus can be described, predicted and controlled in a quite reasonable way. Empirical uncertainty therefore again is very low in Gasen.

Aleatoric uncertainty

The aleatoric uncertainty for the two natural hazard processes differs: The numerous torrent events in the last century have led to a high problem awareness, a high willingness to pay for control measures, and preparedness. This subsequently allows for a low aleatoric uncertainty. However, the numerous damages of even small landslides clearly indicate an underestimation of landslide risks. Five years after the catastrophic events, the risk situation is much better under control, but the low frequency character of the landslides clearly indicates high aleatoric uncertainty. It would therefore be recommendable for the community to regularly inform the inhabitants about the possible problems and to actively work against the trend of "societal memory loss".

3.1.4 Outlook

The assessment process demonstrated in this chapter outlines the method in a qualitative way. For the future an assessment tool should support this process in a quantitative and semi- quantitative way. Using these methods, comparisons between communities could be performed and action plans derived in a more specific manner.

E Conclusions

Over the past years, the concept of risk governance has been promoted in many risk management procedures. However, the practical implementation is still lacking behind, especially when dealing with climate change related risks. Here, a variety of actors, multiple levels of governance and cross-sectoral coordination are important challenges, which are not easy to handle. Up to now there is still a need to raise awareness among decision-makers about potential benefits of a well established risk governance structure in a region. Multiple stakeholders are involved in any step of the decision process. Among these stakeholders, spatial planning can play a potentially important role. Anyhow, decision tools are necessary to help tackling climate change related risks, e.g. for assessing the climate fitness of spatial planning instruments (cf. CLISP WP5) or in more detailed studies in determining the vulnerability on local level. In addition, a good communication practice fosters a higher acceptance of decisions.

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