CapHaz-Net

Social Capacity Building
for Natural Hazards
Toward More Resilient
Societies

Risk perception and natural hazards

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Date	**09/2010**
Report Number	**WP3 report**
Location	**Stuttgart**
Deliverable Number	**D3.1**

Document information

Title	Risk perception and natural hazards
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Distribution	Public
Document Reference	D3.1 – Version 3

Document history

Date	Revision	Prepared by	Organisation	Approved by	Notes
26/02/2010	Version 1.0	Wachinger Gisela	DIALOGIK	Consortium	
13/09/2010	Version 2.0	Wachinger Gisela	DIALOGIK	External readers	
1/12/2010	Version 3.0	Wachinger Gisela	DIALOGIK	UFZ	

Acknowledgement

The work described in this publication was supported by the European Union (European Commission, FP7 Contract No. 227073).

Recommended citation format

Wachinger, G & Renn, O (2010): Risk Perception and Natural Hazards. CapHaz-Net WP3 Report, DIALOGIK Non-Profit Institute for Communication and Cooperative Research, Stuttgart (available at: http://caphaz-net.org/outcomes-results/CapHaz-Net_WP3_Risk-Perception.pdf).

Preamble

This report is the final version of CapHaz-Net's Work package (WP) 3 on risk perception and natural hazards. It is part of the project's broader efforts to review the state of the art of social science research on natural hazards and disasters. Together with the report on 'Social Vulnerability' (WP4) it was discussed during a workshop on 11 & 12 March 2010 in Haigerloch, Germany. This workshop was an unique opportunity to discuss the ideas presented in this report with a number of experts in this field and to further improve the content and the structure of the WP 3 report. Thanks to all experts, the very helpful remarks, comments and case study contributions were included into this version 1.2. of the WP3 report. But still this collection of experience in the field of natural hazard perception in Europe is an ongoing process. All critical remarks as well as further state-of-the-art knowledge, examples of 'good' and 'bad' practices in the field of natural hazard mitigation and adaptation, case study descriptions as well as open research questions are very welcome.

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Structure

Introduction to this report

In this review we aim to address the underlying issue of how we may build social resilience to natural hazards through addressing the issue of risk perception. It asks the question; does the perception of the risks posed by natural hazards influence the ability to build social capacity to cope with such hazards? Whilst there is an extensive risk perception literature, if we are to understand how risk perception concepts can be used to work toward more resilient societies more research is needed.

Therefore this review provides an introduction to the risk perception concept (Part I) followed by an overview of the recent literature in the field of risk perception of natural hazards (Part II). This will take the form of an annotated literature list, structured around a series of questions, raised by this literature. These questions will not only help to focus on the central aspects of the reviewed literature, but also to define research gaps and propose directions for future projects.

As CapHaz-Net is the first primarily social-science project on natural hazards funded by the European Commission and because the authors of this review are from different fields (natural and social sciences), the literature is selected with the focus on bridging a gap between these sciences.

Part III aims to bring together the findings of the previous two sections in order to develop a research concept that will enable insights into the connections between perception and behaviour and the social dimensions of 'natural' hazards. The eventual aim is to be able to provide guidance on how risk perception may be incorporated into disaster management.

PART I: General Concepts

1 Risk perception

1.1 Social vulnerability in context

The perception of risks involves the process of collecting, selecting and interpreting signals about uncertain impacts of events, activities or technologies. These signals can refer to direct observation (for example witnessing a car accident) or information from others (for example reading about nuclear power in the newspaper). Perceptions may differ depending on the type of risk, the risk context, the personality of the individual, and the social context.

What is a risk? In the natural sciences the term risk seems to be clearly defined, it means the probability distribution of adverse effects, but the everyday use of risk has different connotations (Renn, 2008). In most social contexts, "risk" refers to the likelihood of an adverse effect resulting from an event or an activity, rather than an opportunity for desired outcomes. The two terms, hazards and risks, are often used interchangeably by the public. Here we review the risk perception research but in relation to natural hazards (see section 3).

How are risks perceived? Knowledge, experience, values, attitudes and feelings all influence the thinking and judgement of people about the seriousness and acceptability of risks. Within the social sciences however the terminology of ‘risk perception’ has become the conventional standard (Slovic, 1987). Yet risks cannot be ‘perceived’ in the sense of being taken up by the human senses, as are images of real phenomena. The mental models and other psychological mechanisms which people use to judge risks (such as cognitive heuristics and risk images) are internalized through social and cultural learning and constantly moderated (reinforced, modified, amplified or attenuated) by media reports, peer influences and other communication processes (Morgan et al., 2001).

1.2 Perspectives on risk perception: realist versus constructivist views

There are two main approaches to the study of risk perception, the realist approach and the constructivist approach (Renn, 2008: 2). The realist approach to risk could be described as aiming ‘to bring perception as close as possible to the objective risk of an activity or an event‘. It assumes that there is an outside objective world with risks that we can recognize and acknowledge (Rosa, 1998; Rosa, 2008). The solutions to problems of perception are then simply ones of more information and a greater understanding of the risk. The risk itself is not questioned. But are likelihoods or even probabilities real phenomena? Constructivists argue that risk is not objective but that they are subjective and socially constructed (Jasanoff, 1998). That is they are models which allow people to cope with non-reoccurring phenomena.

In this review we will address in detail the connection between realist and constructivist views as they relate to natural hazards (see section 4). In order to do this, we will address the factors which influence the perception of risks in both individuals and groups. Based on this review, we will try to show which factors are especially relevant for the perception of natural hazards in Europe. We will attempt to address why it is that risk perception is a ‘black box’ for experts from the natural sciences? Likewise we need to consider whether there is a similar “black box” when it comes to the social science experts, who have difficulty understanding the rationale of natural scientists approach to risks. In section 4 we will try to shed some light in both approaches in order to achieve a better understanding of the perception of natural hazards.

Cultural patterns and qualitative context variables

In the course of cultural evolution, the basic patterns of reaction to a risk (flight, fight, play dead or experimentation (on the basis of trial and error)) were increasingly supplemented with cultural patterns (for reviewed literature see Renn, 2008). Cultural patterns can be described by so-called qualitative evaluation characteristics and, in the school of psychometrics, are measured by using numerical scaling techniques. This approach to risk research was originally developed by the Oregon Group (see Fischhoff et al, 1978; Slovic et al, 1980; Slovic et al, 1986; Slovic, 1992).

Psychometric methods provide an empirically driven explanation of why individuals do not base their risk judgements on subjectively expected utilities. The research revealed several contextual characteristics that individual decision-makers use when assessing and evaluating risks (Fischhoff et al, 1978; Slovic, 1987, Rohrmann and Renn, 2000; Renn et al, 2008). The following contextual variables of risk have been found to affect people's judgements about risks (Renn, 2008: 109):

Table 1.1: List of important qualitative risk characteristics (source: Renn, 2008: 109)

Qualitative characteristics	Direction of influence
Personal control	Increases risk tolerance
Institutional control	Depends upon confidence in institutional performance
Voluntariness	Increases risk tolerance
Familiarity	Increases risk tolerance
Dread	Decreases risk tolerance
Inequitable distribution of risks and benefits	Depends upon individual utility; strong social incentive for rejecting risks
Artificiality of risk source	Amplifies attention to risk; often decreases risk tolerance
Blame	Increases quest for social and political responses

The question is whether and to what degree these risk characteristics also determine the perception of natural hazards. This question will be addressed in section 3. Another option of grouping and classifying contextual variables is to construct typical patterns – so-called semantic images – which serve as orientations for individuals. This topic is explained and discussed in the following section.

Semantic images

The study of heuristics looks at the everyday mental strategies that people employ when thinking about risk. People evaluate risk according to their subjective perception. Risk perception is governed by psychological mechanisms for processing uncertainty, intuitive heuristics for reaching generalisations and conclusions and additional contextual characteristics. Research on risk perception has identified a range of perception patterns that relate to key characteristics of the risk itself or the context in which the risk is taken. These patterns are called *semantic risk images* (Renn, 1989; Jaeger et al, 2001: 105ff; Streffer et al, 2003; Renn, 2004; Renn et al, 2007).

The semantic images allow individuals to classify various risks on the basis of a few salient characteristics. Reducing complexity by creating classes of similar phenomena is certainly a major strategy for coping with information overload and uncertainty. The five semantic images

are powerful guides that help individuals to navigate through an abundance of often contradictory information. They provide an efficient method of balancing the time for collecting and processing information with the personal need for orientation and attitude formation.

Although these semantic images have not been directly tested in empirical experiments or surveys, they have been deduced from statistical processing of data from studies of qualitative characteristics. In general, five distinct semantic images have been identified (Renn, 2008: 112 see Table 1.2). In addition to these five images, additional images of risk exist for habitual and lifestyle risks that are, however, less clear in their composition and structure.

Some risk sources evoke more than one semantic image. For natural hazards the ‘stroke of fate’ is particularly interesting, but the ’belief in personal control’ also needs to be discussed in detail (see section 3).

Table 1.2: The four semantic images of risk perception (Renn, 2008)

1. Emerging danger (fatal threat)
Artificial risk source
Large catastrophic potential
Inequitable risk-benefit distribution
Perception of randomness as a threat
2. Stroke of Fate
Natural risk source
Belief in cycles (not perceived as a random event)
Belief in personal control (can be mastered by oneself)
Accessible through human senses
Personal control over degree of risk
Personal skills necessary to master danger
Voluntary activity
Non-catastrophic consequences
3. Gamble
Confined to monetary gains and losses
Orientation towards variance of distribution rather than expected value
Asymmetry between risks and gains
Dominance of probabilistic thinking
4. Indicator of insidious danger (slow killer)
(Artificial) ingredient in food, water or air
Delayed effects; non-catastrophic
Contingent upon information rather than experience
Quest for deterministic risk management
Strong incentive for blame

An integrative model of risk perception

In the past the psychological, social and cultural factors hat influence risk perceptions have been investigated within the disciplines in which they reside. However, these different factors are all interconnected and reinforce or attenuate each other. Taking these interactions into account Renn and Rohrmann (2000) developed a structured framework that provides an integrative and systematic perspective on risk perception. Figure 1.1 illustrates this perspective by suggesting four distinct context levels (originally presented by Renn and Rohrmann, 2000: 221; adaptation of the generic model in Breakwell, 1994).

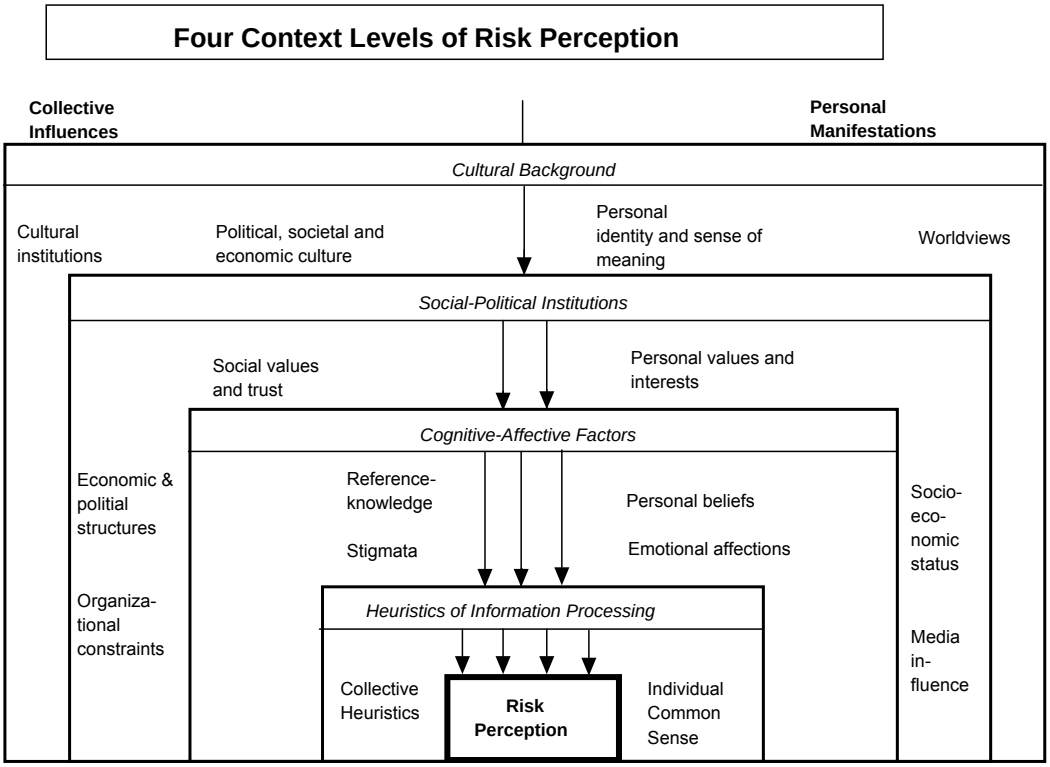


Figure 1.1: **Four context levels of risk perception (Renn, 2008)**

Each level is further divided in two subsections, representing individual and collective manifestations of risk perceptions. Each level is embedded in the higher level to highlight the mutual contingencies and interdependencies among and between individual, social and cultural variables.

Level 1: Heuristics of information processing: The first level includes the collective and individual heuristics that individuals apply during the process of forming judgements. These heuristics are independent of the nature of the risk in question or the personal beliefs, emotions or other conscious perception patterns of the individual. Heuristics represent common-sense reasoning strategies that have evolved over the course of biological and cultural evolution (Ross 1977; Kahneman and Tversky, 1979; Breakwell, 2007). They may differ between cultures; but most evidence in the field of psychological research shows a surprising degree of universality in applying these heuristics across different cultures (Renn and Rohrmann, 2000). Improved knowledge and expertise in logical reasoning and inferential statistics, as well as a conscious awareness of these heuristics, can help individuals to correct their intuitive judgements or to apply these heuristics to situations where they seem appropriate. Recent research results suggest that these heuristics are more appropriate for problem solving in many everyday situations than previously assumed (Gigerenzer and Selten, 2001). Regardless of the normative value that these heuristics may offer, they represent primary mechanisms of selecting, memorizing and processing signals from the outside world and pre-shape the judgements about the seriousness of the risk in question.

Level 2: Cognitive and affective factors: The second level refers to the cognitive (knowledge-based) and affective (emotion-based) factors that influence the perception of specific properties of the risk in question. Cognition about a risk source – what people believe to be true about a risk – governs the attribution of qualitative characteristics (psychometric variables) to specific risks (e.g. dread or personal control options) and determines the effectiveness of these qualitative risk characteristics on the perceived seriousness of risk and the judgement about acceptability (Slovic, 1992). It is interesting to note that different cognitive processes can lead to the same attribution result. In an empirical study, Rosa et al, (2000) were able to show that for the Japanese sample the arousal of catastrophic images was associated with the degree of individual knowledge of and familiarity with the respective risk in question, whereas US respondents linked collective scientific experience and knowledge to catastrophic potential. The two samples were, however, identical in assigning the degree of catastrophic potential to a set of technologies, even if they had different mental models about what constitutes catastrophic potential. The fact that individuals, within their own culture or by their own agency, are able to choose between different cognitive routes justifies the distinction between the two primary levels: cognitive factors and heuristics.

Whilst cognitive factors have been extensively explored, emotions have in the past been widely neglected in risk perception research (Breakwell, 2007). More recently, however, psychologists have discovered that affect and emotions play an important role in people's decision processes (Loewenstein et al, 2001; Slovic et al, 2002). People's feelings about what is good or bad in terms of the causes and consequences of risks colour their beliefs about the risk and, in addition, influence their process of balancing potential benefits and risks. Affective factors are particularly relevant when individuals face a decision that involves a difficult trade-off between attributes, or where there is interpretative ambiguity as to what constitutes a 'right' answer. In these cases, people often appear to resolve problems by focusing on those cues that send the strongest affective signals (see and Kunreuther, 2000; Peters et al, 2004). On the collective level, stigmata referring to risk sources or activities play a similar role in stimulating emotional responses (Slovic et al, 2002). Empirical studies regarding technological hazards show that emotional and cognitive factors are mutually related (Zwick and Renn, 1998). It is not yet clear whether cognitive beliefs trigger off the respective emotional responses or whether emotional impulses act as heuristic strategies to select or develop arguments supporting one's emotional stance.

Kobbeltved et al. (2005) investigated the causal connection between risk, worry and emotional distress. The "Risk as feelings-hypothesis" postulated by Loewenstein et al. in 2001 predicted a direct effect from feelings onto behavioural choices. Exploring the perceived risk and related feelings among navy personnel who participated in an international operation, Knobbelved et al. found no reciprocal relation between judgement of risk and feelings but an impact from risk on worry.

Level 3: Social and political institutions: The third level refers to the social and political institutions that individuals and groups associate with either the cause of the risk or the risk itself. Most studies on this level focus on trust in institutions, personal and social value commitments, organizational constraints, social and political structures, and socio-economic status. One important factor in evaluating risk is the perception of fairness and justice in allocating benefits and risks to different individuals and social groups (Linnerooth-Bayer and Fitzgerald, 1996).

Theoretical approaches, such as reflexive modernization (Beck 1994) or the social arena metaphor (Jaeger et al, 2001), provide a plausible explanation of why the debate on equity and justice has become so relevant for risk perception (Knight and Warland, 2005). Other studies have placed political and social organizations, and their strategies to communicate with other organizations and society at large as the prime focus of their attention (Clarke, 1989; Shubik, 1991).

The media, the perceived norms and values of one's reference group (this is the group to which one would like to or believes they to belong to) and organizations also shape individual and societal risk experience. Press coverage appears to contribute substantially to a person's perception of risk, particularly if the person lacks personal experience with the risk and is unable to verify claims of risks or benefits from their own experience. In contrast to popular belief, however, there is no evidence that the media create opinions about risks or even determine risk perceptions. Studies on media reception rather suggest that people select elements from media reports and use their own frame of reference to create understanding and meaning. Most people reconfirm existing attitudes when reading or viewing media reports (Peters, 1991; Dunwoody 1992; Breakwell 2007).

Level 4: Cultural background: The last level refers to cultural factors that govern or co-determine many of the lower levels of influence. The most specific explanation for cultural differences about risk perceptions comes from the so-called 'cultural theory of risk'. This theory claims that there are four or, in some studies, five prototypes of responses to risk (Thompson, 1980; Douglas and Wildavsky, 1982; Thompson et al, 1990). These prototypes refer to entrepreneurs, egalitarians, hierarchists, atomized individuals and, as a separate category, hermits. Opinions on the validity of the cultural theory of risk differ widely. Slovic et al (2000) regard this approach as useful in explaining some of the differences in risk perception; Sjöberg (2001) and Sjöberg et al (2000) found the variance explained by cultural prototypes to be so low that they rejected the whole concept. Rohrmann (2000) also expressed a sceptical view, mainly because of methodological considerations about the empirical validity of the claims. All authors agree, however, that specific culture-based preferences and biases are, indeed, important factors in risk perception. The disagreement is about the relevance of the postulated four or five prototypes within the realm of cultural factors.

In addition to the theory of cultural prototypes, there are two sociological concepts that provide plausible explanations for the link between macro-sociological developments and risk perceptions. The theory of reflexive modernization claims that individualization, pluralisation and globalization have contributed to the decline of legitimacy with respect to risk professionals and managers (Beck, 1994; Mythen, 2005). Due to this loss of confidence in private and public institutions, people have become sceptical about the promises of modernity and evaluate the acceptability of risks according to the perceived interest and hidden agenda of those who want society to accept these risks (Beck, 1992). The second approach picks up the concept of social arenas in which powerful groups struggle for resources in order to pursue their interest and objectives. Here, symbolic connotations constructed by these interest groups act as powerful shaping instruments for eliciting new beliefs or emotions about the risk or the source of risk (Renn, 1992; Jager et al, 2001).

All four levels of influence are relevant in order to gain a better and more accurate understanding of risk perception. In spite of many questions and ambiguities in risk perception research, one conclusion is beyond any doubt: abstracting the risk concept to a rigid formula, and reducing it to the two components' 'probability and consequences', does not match people's intuitive thinking of what is important when making judgements about the acceptability of risks, in particular technological risks (Mazur, 1987; Pidgeon, 1997; Wilkinson, 2001). Paul Slovic (1992: 150) stated this point quite clearly: "To understand risk perception, one needs to study the psychological, social and cultural components and, in particular, their mutual interactions. The framework of social amplification may assist researchers and risk managers to forge such an integrative perspective on risk perception. Yet, a theory of risk perception that offers an integrative, as well as empirically valid, approach to understanding and explaining risk perception is still missing".

PART II: Overview of the recent literature of the perception of natural hazards

In Part II the authors want to briefly present an overview of the recently published studies on natural hazard perception. The aim of this is not to rank or evaluate the different approaches but to characterise the current social science research on risk perception of natural hazards. This does not, however, imply that the list is complete or exhaustive. The aim is to represent the main contributions to this field from an interdisciplinary perspective. The bibliography is structured around the comparison between natural and “non-natural” (antropogenic) hazards and regional perception-differences (section 2), around the characteristics of natural hazards and disasters which are most likely to influence risk perception (section 3), around the factors triggering perception in different regions in Europe (section 4), and around three case studies for floods, droughts and alpine hazards (section 5).

It is in Part III that we will attempt to synthesize this work and to suggest recommendations for implementing the results from these studies into risk governance, as well as proposals for future research.

2 Perception of natural hazards

2.1 Differences in perception of natural hazards to non-natural hazards

Within this section we will review the specific dimensions of risk perception with respect to both natural and non-natural hazards. It is a challenge to define and specify what we mean when talking about natural hazards and non-natural hazards. Whilst it is clear that the 'non-natural hazards' term is intended to refer to human induced hazards (or, in other words, hazards which are caused by the application and use of human technology or human activities), the level reached by technology has invested its consequences with the power of affecting the environment on a world wide scale (i. e. Climate change). Consequently, there is sufficient evidence, provided by numerous case studies, to maintain that a notable number of disasters traditionally caused by natural factors were, in fact, mainly generated by human practices and their effects on the environment (García, 2005, 16, Arranz, 2003: 2). Conceptually it is not straightforward to separate and differentiate natural hazards caused or aggravated by human actions (which could be defined both as natural hazards and as humanly induced hazards) and entirely natural ones, which take place without human intervention. However it is the differences of perception, between the categories of natural and non-natural hazards that are examined here.

There are two main perspectives in the study of risk perception (Plapp and Werner, 2006: 102; Plapp, 2001: 3): The concept of cultural theory (Douglas and Wildavsky, 1983; Thomson, 1990) and the psychometric paradigm (Slovic, 2000: 226-227). The concept of cultural theory examines the cultural prototypes, which act as the basis of the individual's construction of their cognitive categories (García, 2005: 15), whilst the psychometric paradigm goes beyond the individual's social context, paying attention to those elements that are shared across cultures and social groups. The following paragraphs discuss the difference in perception of natural and non-natural hazards from within both of these perspectives.

Cost-benefit consideration

One approach to risk looks at the costs in relation to the potential benefits. This perspective focuses on the economic context of the individual. Given this point of view, the economic factor (the possibility of benefiting despite of its potential risks) emerges as one of the main determinants in risk perception (Jaeger et al, 2001). Although a specific location or context may generate a certain risk, it is also true that the same context can provide benefits. Numerous case studies have documented how the balance between risks and benefits as estimated by the individual can be a determinant factor influencing risk perception (Fischoff, 1981). However this happens more frequently when we are talking about a risk generated by technology. Nevertheless, there are also cases of this social process regarding natural hazards.

An interesting view was observed in a technical risk case: in 2000, while Leonid Kuchma, president of Ukraine ordered the final shut down of the third reactor of the Chernobyl Nuclear Plant, a Spanish reporter collected the statements of engineers and workers of the nuclear plant. Most of them were concerned mainly with the loss of such a well paid job (Lopez, 2001). A similar case can be found in the Nuclear Power Plant of Valdecaballeros (Spain), which was closed down when the nuclear moratorium of 1983 came into force. Villagers actively protested

against the dismantling of the power plant (Arranz, 2003:6) as it would have provided a substantial benefit for the town and an increase of personal income to the villagers.

As well as economic considerations other factors may influence risk perception. People may feel connected to a particular place or context in such a way that the risk factor forms part of their identity. A situation that seems more common in the case of 'natural hazards': for example people in Yungay in Peru didn't want to move from their homeland despite the risk from earthquakes (Oliver-Smith, 1986). Hence, they accept and coexist with the hazard, even, developing an emotional link with it, which downplays its potential risks (Arranz, 2003). Certain political tendencies, ideologies and other social affiliations which entail a value compulsion may also have a crucial function in defining the individual's risk perception. A paradigmatic example can be found in the case of some parts of Australia, where a strong nationalist feeling downplayed the perception of a constant risk of drought (Heathcote, 1969).

The psychometric paradigm

The psychometric paradigm perspective focuses specifically on the psychological view of the human reasoning: the way we draw conclusions and how we act accordingly. In other words, this perspective tries to study various risk characteristics or risk dimensions to explain the sometimes apparently irrational perceptions of laypersons (and of experts, too, see Sterman, 2008). The aim of this approach is the understanding of the cognitive structure of risk (Plapp, 2001). Therefore, the psychometric paradigm focuses on a group of concepts mainly related with human psychology. In section 3 the factors of risk perception of natural hazards will be shown in detail.

There is some evidence that technological risks may be seen as more dreadful than 'natural' ones. Authors such as Erikson have shown how this kind of hazard are usually related with an invisible, imperceptible and corrupting nature, which, like a poison, is able to penetrate into the body and, even, into the genetic material of the people, affecting not only them, but their offspring as well. These hazards are seen to "contaminate rather than merely damage; pollute, befoul and taint rather than just create wreckage; penetrate human tissue indirectly rather than wound the surface by assault […]" (1990: 120). Unlike natural hazards, these dangers are unbound and indirect. While it is true that not every technological hazard has this nature (for example, a nuclear explosion is, obviously, very perceptible), most of them are feared because of their combination of imperceptibility and the advanced knowledge required to understand their functioning.

In contrast natural hazards often seem to happen in a more direct way, often with no one to blame and sometimes no way of preventing them from happening. (However, as will be discussed later this may be changing, at least for particular hazards and contexts). Despite their capabilities to cause devastation, this impact is direct and perceptible. Sjöberg (1998) defined this kind of risk as sensorials while the risks produced by technology are cognitive. This highlights the requirement of a certain level of education to understand or even to be aware of the hazard (1998:88). In addition, technological hazards are usually linked with a group of visible and socially conceptualised items (like smoking chimneys, barrels, radiation or biohazard symbols, etc.) which act as a symbolic reminder of the presence of the hazards and their effects over the environment. All these elements make the technologic hazards a dreadful category in terms of risk perception. Natural hazards tend to rate lower in the risk perception scale: empirical

results show that they caused less fear than non-natural hazards (Plapp and Werner, 2006: 107).

In contrast to natural hazards, technological hazards are conceptualised as relatively new or unknown, thus, they are considered uncertain and unfamiliar (both items which contribute to increase the feeling of risk). As most people do not possess the detailed knowledge of the risk they represent they are forced to rely on experts and managers. As it will be shown in detail in 3.8, trust is used as a shortcut to reduce the necessity of making rational judgments based on knowledge by selecting trustworthy experts whose opinion can be considered as accurate (Siegrist and Cvetkovich, 2000: 714). This can result in a reduction of the uncertainty, but due to the fundamental affective dimension of trust (which involves items like honesty, integrity, good will or lack of particular interests), the people may feel more at risk if their trust in experts is lacking or damaged (Espluga, 2009: 268).

In summary, for all the reasons discussed briefly above, diverse authors have concluded that, despite the immense damage they are capable of causing; natural hazards rate relatively low on the perceived risks structure compared with the technological hazards (Plapp and Werner, 2006: 107; Slovic, 1996: 171-172; McDaniels, et al., 1995: 587).

2.2 Regional perception differences within Europe

This section aims to identify differences between various countries in Europe as regards to risk perception, however it is important to acknowledge that the hazards compared are of different kinds. It is possible to identify though, some indicators that could be of considerable importance in terms of regional differences in risk perception. The main regional characteristics that seem to influence risk perception (beside geographical characteristics (Weichselgartner, 2001, Schmidt-Thomé, 2004) are: Firstly the role of authorities in terms of risk communication and disaster risk reduction. Secondly, the moment of occurrence of the disaster as regards to the first point – whether the disaster happens in a moment characterised by preparedness or not – and the frequency and degree of devastation of particular disasters. Thirdly, social, economic and political contexts at local, regional and national levels have considerable influence on risk perception. And finally, the last point to be discussed in this section focuses on personal values and interests that are significant in risk perception analysis. These four points will be discussed with reference to case studies from different European countries, focusing mainly on floods and droughts.

The role of authorities and the nature of the disasters

In several of the reviewed case studies the role of the authorities in terms of risk communication and disaster risk reduction seem to be especially important for people's risk perception of natural hazards .There also seems to be a relation between governments' actions and the nature of the disasters, specifically the frequency and the degree of devastation. Due to these findings, this section will highlight the ways in which these two aspects seem to depend on each other and the way they influence people's risk perception. The findings from three case studies; the Netherlands, Norway and France, will be compared.

In the case study from the Netherlands it is indicated that public risk perception changed after flooding was experienced. Before 1993, floods were not perceived as a risk (Bezuyen et al. 1998:47) and there was a lack of preparedness. In contrast the second flood was characterised

by an efficient evacuation of people. This was not only due to a well prepared disaster relief and evacuation plan and good coordination between authorities, but also to the self-regulating behaviour of the residents (Bezuyen et al. 1998:43-49). In comparison, the case study from Norway found that whereas people had a good awareness of the possibility of floods, they thought that it would not happen to them (Krasovskaia et al. 2001:864-865). (See also 3.1 for how experience changes perception).

In some ways this was similar to the situation in the Netherlands before the 1993 flood, however, interestingly the residents in the Norway case study stated that they would not obey an evacuation order and neither did they believe they would be in danger in a flood situation. Perhaps, this difference could be due to the higher frequency and devastation caused by the floods in the Netherlands. Although it must be noted that some of the residents in the Norway case study had experienced floods. In this regard, it is important to highlight the possible differences between perception and actual behaviour in a disaster situation. Even though many of the people in the Norway case study claimed that they would not obey an evacuation order, this might change in a real flood situation. However, it is crucial to acknowledge the role of the authorities as regards to differences in risk perception. In the Netherlands the authorities anticipated the hazards and were able to put into practice their evacuation plan, which could be seen to affect the risk felt by people.

As regards to the point of authority involvement, a study of the 2003 heat wave in France shows that the French government before and during this disaster downplayed the risk of a heat wave (Poumadere et al. 2005:1492). Poumadere et al. (2005:1490) indicates that reasons for the lack of concern by the French public included high levels of trust in experts and health officials as well as fatalism among the people, at least before the 2003 heat wave. The presence of the 1985 Disaster Act in Netherlands and the lack of any policy preparedness in France for the heat waves show two very different responses to natural hazards based on the social perception of risks from these natural disasters. Yet the difference in policy, greatly effects the mortality and further impact economically, social and for recovery purposes that a natural disaster may have on a population (Poumadere, 2005, Bezuyen,1998).

Social, economic and political contexts

As stated by Poumadére et al. (2005:1483), societal and contextual aspects are linked to and mediate perceptions and impacts of a disaster. In a study of risk perception among organic farmers in Spain, Medina et al. (2007: 21) indicated that “risk perception depends on many variables such as type of culture, the zone of cultivation, the formation of the producer, the special characteristics of the cultivation, etc.”. Additionally, Downing et al. (2001) found that the trends in patterns of thought and action, perception and behaviour that influence the social constructions of hydrological risk interact with ongoing processes at the local levels, such as marketisation or changing myths of nature. Thus, one can state that the wider social, economic and political contexts at local, regional and national levels are significant factors that influence risk perception. There is a need, though, for further studies that look at the interrelations between these levels in various regions in order to be able to compare and generalize as regards to regional differences.

Personal values and interests

One would also have to account for the influence of values and interests of the people in risk perception. According to Weiss (2009), the values and interests are often guided by social norms developed by institutions (i.e. governments, cultural institutions, family institutions). Thus, the role of the institutions can be seen to create regional differences in risk perception of disasters. In the case report on the 2003 heat wave in France the common attitude seemed to be “until they warn me I don’t have to worry”, a phrase that indicates a high level of trust in the governmental institutions. With regards to the issue of trust, Lorenzoni and Pidgeon (2006: 89) state that “there is scope for more detailed work on how individuals’ views, and perhaps even behaviour, could be related to trust in institutions”. Furthermore, the study from France acknowledges the rejection of risk due to an ideal of youth and well-being in society, whereas the most vulnerable groups in a heat wave are the elderly, isolated, sick, and poor (Poumadére et al. 2005: 1489). This is a clear example of how social values and interests, often influenced by social norms, influence risk perception. Flooding risk (as well as the value of water as a resource) was seen differently by hierachists, egalitarian, individualists and fatalists (Hoeckstra, 1998). Marris et al. (1998) have reported a difference of trust between these four different cultural groups’. All these groups preferred to rely on people that they know personally (doctors, friends, family) and on environmental organisations rather than on other institutions. Hierarchists and (surprisingly) also individualists trusted in the government, but egalitarists and fatalists did not.

Messner and Meyer (2005) affirm that risk judgements vary due to a number of factors: different levels of information and uncertainty, different intuitive behaviour and different power constellations and positions of interest. Thus, in order to account for regional differences in perception one would have to look at the underlying structures of information sharing and power that might influence risk perception. When discussing regional differences it is also crucial to look at the ways in which individuals’ beliefs, values and worldviews may influence the way people perceive disaster risk (Slimak and Dietz 2006: 1703). It is difficult to state specific regional differences on the basis of these case studies as they focus on different aspects and different hazards. It is interesting to note the general characteristics that might generate regional differences, but in order to state that there are clear differences between various regions in Europe one would have to undertake a much more profound study of each region encompassing the wider social, economic, political, and ecological contexts.

3 The background of risk perception factors of natural hazards

In this section we aim to provide an overview of the recent risk perception literature on natural hazards from the perspective of both the natural and the social sciences. The section examines the following topics: probability and magnitude, scales, extreme events and lag phases, complexity, uncertainty, ambiguity, trust, and the amplification and attenuation of risks. Each of these topics raises specific research questions and these are listed at the beginning of each section. For every topic we also provide a 'working hypothesis' or 'take home message' at the start of the section. These statements have been discussed in the WP3/WP4 meeting in Haigerloch. The experts attending the meeting in Haigerloch provided further contributions to the literature reviewed and, even more important, told about studies in practise, which have not yet been published. These contributions are reviewed and discussed in section 4.

3.1 The problem of 'experts'

- *Who is perceived as an expert?*
- *What is the role of lay knowledge in risk perception?*
- *Is there any influence of education on risk perception?*

There are different types of 'experts' in the field of natural hazards: a) scientists of different disciplines, working in this field, b) people ('lay or local experts"), who have experienced an event, and c) people, who have a specialist knowledge relating to the risk (for example weather conditions, local decision pathways).

Whether the knowledge of the different types of experts plays a role in risk governance is very much dependent on the particular case study. .In general, the routes by which people arrive at particular perceptions differ between scientific experts and lay people. But the differences between non-experts and experts seem to be overestimated: experts are also subject to basic mechanisms of perception. The differences between different individuals are much higher than that between lay and expert persons.

The distinction between so called 'experts and 'lay' people' is more complex than it might at first appear. The definition of who is an 'expert' is sensitive and needs to be approached with caution. At times the label of expert can invite suspicion from the public (Margolis, 1996 cited in Botterill and Mazur, 2004), whereas in other cases expert opinion is trusted (Margolis, 1996). However it is not always clear why there is this difference. Hood et al. (2001) suggest that this is because of a general decline in people's faith/trust? in science. They argue that previous generations' faith in the ability of science to provide answers has turned to doubt. This is partly because scientists themselves are unable to agree, partly because the answers science provides are more complex and contingent and partly because the answers appear to change over time. This declining trust in science and its experts are one of the tenets of post-modern science (De Marchi and Ravetz, 1999). As section 3.9 will discuss, trust is an important factor in this relationship between 'experts' and 'non experts'.

The question we need to consider here is the extent to which the perception of natural hazards differs between experts and non-experts. The recent literature concerning different hazards shows controversial results. Kraus et al. (1992) observed a difference between the expert judgement of toxicological risks and the intuitive toxicologists (lay persons). But the judgement differences between the experts were so high, that he suggested that "the

controversies over chemical risks may be fuelled as much by limitations of the science of risk assessment and disagreements among experts as by public misconceptions." The educational background for example didn't appear to alter the perception of a risk very much; other factors had more influence (Kraus et al., 1992). Similarly training in sciences made no difference in understanding a factor of climate change as a complex system (Sterman, 2008, see below). This would seem to suggest that the division between lay and expert is not necessarily the most significant in risk perception.

Research in Switzerland looking at the perception of flood risks found some similarities between the experts and those lay people who live in areas of high flood risk: Siegrist and Gutscher (2006) found a spatial correlation, when asked to identify flood risk areas, between risk perceptions of the public and experts risk assessments. In areas which have flooded in the past (and where the experts have been indicating a high flood risk) people were more aware of the risk. This seems to be because "people, who could remember flood events, perceived greater flood-associated risks than people who could not remember such adverse events" (Siegrist and Gutscher, 2006: 977). A lay expert (someone who has been flooded) seems to perceive flood risk in a similar way to that of an expert, whose risk perception is based on numbers. Studies in other countries, such as Slovenia, support these findings: the perception of floods depends to a certain degree on the place of residence in a flood area (Brilly and Polic, 2005). This would suggest, for floods at least, that previous experience is a key factor in the perception of risk. A survey of at-risk householders in England supports this finding. The research indicated that "the main factor driving behavioural responses to flood risk is experience of flooding. People with some experience of household flooding are more than six times as likely to take resilience or protection measures." (Harries, in press). The evidence, from floods at least, would seem to suggest that experience of a natural hazard influences both the perceived risk and the likely behaviour. The increased awareness of risks following such experience, seems to bring them more into line with the experts perception.

However, the behaviour resulting from flood experience is not always what might be expected. For example people at a German flood site believed that following a '100 year flood' it would take another 100 years before the next flood would occur (Renn, 2008). They were therefore unwilling to prepare for the next flood. Awareness or experience of a natural hazard risk does not necessarily lead to the desired behaviour in terms of preparedness for that risk or the understanding of environmental processes. Learning from experience is not necessarily transferable to environmental processes in general: Witmarsh (2008) when testing the understanding of and responses to climate change has shown, that flood victims in England only differed a little from other participants in the study in their perceptions of climate change.

To explain differences between experts and lay people, the 'natural hazard experience' has to be investigated in detail, because the perception of different characteristics of natural hazards might be influenced by personal knowledge of different groups. In a case study of floods in Spain Raaijmakers et al. (2008) questioned different groups of stakeholders in detail about their awareness, worry and preparedness. The awareness (representing knowledge) was slightly higher in the expert and the local policy makers group compared to the lay people, but he found a high difference in worry which was less in the expert and the local policy makers group than in all other groups of stakeholders. Jurt found in stakeholder discussions, that the history of scientific arguments is also an important factor in flood risk perception of different stakeholder

groups: “if the arguments of scientists matched the villagers’ argument classified as local knowledge, then they were used as reinforcement.” (Jurt, 2009: 246)

The subjective concept of risk perception is useful to provide insights into the factors which trigger the risk perception of both experts and lay persons. Understanding these is therefore a precondition for risk assessment (Plattner, 2006). Our approach, in the remainder of this section, is not to focus on the distinction between lay persons and experts, or between different groups of experts, but rather to try to list the research carried out on the different aspects of natural hazard perception.

3.2 Perception of probability and magnitude

- *Is there an intuitive understanding of probability?*
- *What is the role of probability and magnitude in people’s estimations?*

A risk is not a fact, but a calculation of what probably might happen as the result of an initiating event. Therefore whether and in which way people perceive any risk is very dependent upon their personal abilities and the context. But there also seems to be an intuitive understanding of probabilities: even animals have to decide in uncertain situations and therefore estimate or forecast the likelihood of expected outcomes or events.

When given the risk definition as a factor of probability and magnitude (and reducing the risk- to a number), people seem to overestimate risks of low probability and high magnitude in relation to risks of high probability with less fatal consequences.

To make decisions in risky situations is a daily need not only for humans (or societies) but also for animals. “Humans responses to risky situations derive at least in part, from the same mechanisms evolved by other animals in response to the stochasticity [randomness] of their natural environment” (Weber et al., 2001: 5-6). For the understanding of probability perception it is helpful to know the evolutionary background and this can be studied in animals. But these mechanisms have developed in humans not only on an evolutionary scale but also on an ontogenetic (lifetime) scale and are therefore dependent on the cultural environment of the individuals. Numeracy (the ability to process basic probability and numerical concepts) determines the extent to what people differentiate between risk levels. (Keller et al., 2009): Highly numerate individuals differentiated between risk levels shown on a logarithmic scale to a higher extent than less numerate persons. However it was possible to improve the level of differentiation in both groups upon training. A visualisation of the risk in a risk ladder and comparison of the natural risk with pictures of cigarettes and (the amount representing a comparable smoking risk) (on a logarithmic scale) did help both numeracy-groups to compare different risks and to interpret various risk levels (Keller et al., 2009). The probability information about natural hazards seems to be more available for people if shown in comparison to the more familiar smoking-risk (see table 3.) as long as the comparison does not imply judgments of acceptability.

There is evidence that people overestimate the frequency of low probability events which have severe personal outcomes, in relation to high probably events with small personal impacts. Nascimento et al. (2007: 10) reported that the “dealing with flood probabilistic concepts seems to be ... difficult”, even if “respondents living in flood prone areas revealed a good knowledge of

typical flood parameters". Haimes (2004: 300) found that people asked about floods "are more often concerned with low probability catastrophic events than with more frequently occurring but less severe accidents." This has been shown by different experiments and might have been a selective advantage during evolution. Protecting oneself against a very unlikely but life-threatening catastrophe could have been more necessary in evolutionary terms for a whole population, rather than protecting against small hazards, even if they are more probable. The emotion of fear amplifies risk perception and therefore seems to be a factor that leads to negligence of probability (Sunstein et al., 2008).

Decisions made in risky situations often imply a choice between two possibilities, to run away or not. It then becomes necessary to distinguish quickly between 'safe' and 'unsafe'. This need to quickly choose between two options may seem to bear little relation to the probabilities used by experts. The open space, or uncertainty, between safe and unsafe may be perceived by the public as an indication of bad or incomplete science rather than an indication of (genuine) probability distributions (Jasanoff, 1998). The more people associate uncertainties with a specific technological risk, the more they believe that society needs more science and research to reduce these uncertainties (Sparks et al, 1994; Frewer et al, 2002; De Jonge et al, 2007). But as 3.6.,will illustrate uncertainties exist on different levels and are not all are reducible by scientific research.

Many studies have identified biases in people's ability to draw inferences from probabilistic information (Festinger, 1957; Simon, 1976, 1987; Ross, 1977; Kahneman and Tversky, 1979; reviews in Covello, 1983; Renn, 1990, Boholm, 1998; Jungermann et al, 2005; Breakwell, 2007). These factors altering perceptions of probability in risk contexts are summarized in Table 1.3. Risk managers should be aware of these biases because they shape public risk perception and may be one of the underlying causes for the discrepancy between layperson and expert judgement of risks.

Table 1.3: Intuitive biases of risk perception (source: Renn 2008:103)

Biases	Description
Availability	Events that come immediately to people's minds are rated as more probable than events that are of less personal importance.
Anchoring effect	Probabilities are estimated according to the plausibility of contextual links between cause and effect, but not according to knowledge about statistical frequencies or distributions (people will "anchor" the information that is of personal significance to them).
Personal experience	Singular events experienced in person or associated with the properties of an event are regarded as more typical than information based on frequency of occurrence.
Avoidance of cognitive dissonance	Information that challenges perceived probabilities that are already part of a belief system will either be ignored or downplayed.

3.3 Perception of time scales

- *How are time scales and thresholds in prognostic models perceived? .*
- *Which time scales are important for different natural hazards? .*

The knowledge that in several cases human perception is much better described by a logarithmic function than by a linear function is very old. People seem to have an intuitive feeling of logarithmic and linear numerical scales, if visualized in an appropriate form.

As for floods, droughts and alpine hazards, very different time scales have to be taken into account. Case studies have to prove in detail, how the perception of time scales alters the decision to take precautions against these hazards.

A perception of the logarithmic time scale is necessary for the understanding of environmental processes: Factors on a very short time scale may influence processes on a very large scale. So, for example, bacterial growth, or a small change of a technology may lead to huge effects on climate change (Jaeger and Oppenheimer, 2005).The natural hazards floods, droughts and alpine hazards, which are the subject of this review, also differ in their time scales. Forecasts for hazard events are given on much longer time scales (hundreds of years) than the short time scales (hours and days), on which the influencing processes can be observed and the investigations in risk assessments are undertaken. There is considerable evidence that humans will often use logarithmic rather than numerical scales. As far back as 1850 Weber had found, that human perception of weight differences is not linear but dependent on the absolute weight. When lifting a weight by hand it was possible to distinguish a 2.0 kg from one that weighed 2.2 kg. For a 10kg weight the minimum weight difference that could be distinguished was 1kg. The Weber-Fechner law describes how the magnitude of a subjective sensation increases proportional to the logarithm of the stimulus intensity[1].

Recently a neural activity was found in monkeys, which was related to a decision-making-activity according to Weber's law (Deco et al., 2007). Children and adults seem to have an intuitive feeling of logarithmic scales and with increasing age children learn to find appropriate numerical representations (linear or logarithmic) for numerical estimations (Siegler and Opfer, 2003). The precondition to think on the logarithmic scale is a given, the challenge for scientists is to investigate and explain risk forecasts in an appropriate form. The task for politicians and decision makers is to integrate public perception as well as scientific expertise into risk governance (Zwick and Renn, 2008). One approach could be through visualisation, using a risk ladder (Keller et al., 2009), as mentioned in section 3.2.

[1] Weber's Law states that the ratio of the increment threshold to the background intensity is a constant. The fraction $\Delta I/I$ is known as the Weber fraction.

3.4 Perception of jumps, extreme events, and delay effects

- *Which discontinuities play a role in predicting natural hazards?*
- *What is the perception of delay effects and sudden jumps in processes which trigger natural hazards?*
- *What is the perception of extreme floods, droughts and alpine hazards?*

Risk models (for example in economic sciences) have been based on linear extrapolations of the present (and past) conditions and processes to the future. But recent research papers highlight the importance of jumps, extreme events and delay effects in prognostic models used for forecasting natural hazards, because these events may trigger the whole process. It is not yet known whether including such information will make the communication between experts and laypersons even more complicated. As these non-linear connections and the resulting extreme events are characteristics of a complex system (see 3.5.) the perception of non-linearity has to be taken into account. Case studies of different natural hazards have tried to shed some light on particular aspects of extreme events

A natural hazard event might be harder to predict than other risky situations. Several types of discontinuities on the time scale are triggering the physical and biological factors leading to a flood, a drought or an avalanche. Two of these effects are latency (a delay effect over time) on the one hand and jumps (a sudden high risk or extreme event when the risk level has been low only a short time before) on the other. The delay effect (the latency between an initial event or the risk cause and actual damage, Renn, 2009: 37) is obvious in natural hazard events, but makes perception of the risk (and prognoses as well) very difficult. Droughts have a longer latency after the initial weather event (temperature rise and duration of high temperatures), than floods (snow melting or rain). The shortest delay could be observed in avalanches, which occur when there are particular types of snow in large quantities.

Extreme events are also an obvious characteristic of natural hazards. Small changes in environmental factors such as temperature or rainfall, acting together or in isolation, may lead to a natural hazard event. In linear systems small causes result in small effects. “In non-linear systems, an arbitrary small cause can produce an arbitrary large effect. Therefore the behaviour of non-linear systems is often unforeseeable and also uncontrollable” (Jaeger et al., 2001: 167). Most of the systems in our world (environmental, social, economic) are non-linear, because the connections in a complex system cause non-linear processes (see section 3.5). But how are extreme hazard events, which result out of non-linear processes perceived?

What is meant by extreme is open to interpretation and different measures have been used in relation to hazard events. Several studies have used economic data to define the severity of an event (Olcina Cantos and Ayala-Carcedo, 2002 in Llasat-Botija et al., 2007). The economic value of what is lost provides a measure of the severity. However, other studies found that the event and the level of compensation paid did not correlate well. They argued that better indicators were provided by social surveys (Brilly & Polic, 2005 in Llasat-Botija et al., 2007) or through the number of calls made to emergency services (Petrova, 2004 in Llasat-Botija et.al., 2007). The numbers of injuries or fatalities (death tolls) may also be used as indicators for extreme natural hazard events (Plate 2002; Felgentreff et al., 2008; Betz, 2010). The definition of extreme in the Mulde case study (see section 4), for example, is also based on rarity, as it is related to the ‘flood of the century’ expression (having a probability of 1/200 to 1/250 compared

to 1/100 for a flood prone area (Meyer et al., 2009). Different measuring methods for ‘extreme events’ are used, but there are common characteristics in perception of an extreme event:

In the context of natural hazard perception ‘extreme’ means not only ‘rare’ and ‘severe’ but also ‘surprising’. Often the severity of the event can be related to the degree of preparedness or lack thereof, i.e. surprise. Krasovskaia (2001), points out that extreme events are rare events, and this rarity is part of the reason it comes as such a surprise to residents. Delays and jumps on the time scale can lead to extreme events, which are mentally connected to surprises. Therefore these unexpected changes of the linear time scale have to be taken into account as a factor influencing risk perception.

The media reporting of natural hazards may also have an impact on the perception of the extremity of an event. Research on the Catalonian drought of 2005 found a mismatch between the reporting of events and their severity. Press articles from 1982 to 2005 (Llasat-Botija,M., et.al. 2007), were compared with physical data of the events in question. The research concluded that during the period when floods were the most significant natural risk in Catalonia and despite attracting a fair amount of news coverage, it was the less frequent hazards that had broader coverage and impact per event (Llasat-Botija, et. al., 2007). Through the ‘secondary experience’ of the media, hazards that were less common were now thought to be a major hazard, whilst more common hazards were sidelined due to lack of ‘secondary experience’. The choice of which hazard to emphasise had more to do with the fact that those months where flood hazards are predominant offer many other news items compared to the months of dry hazards (Llasat-Botija, et al., 2007). Therefore media reporting, which may not accurately reflect the severity or frequency of natural hazards, can alter the way in which those events are understood.

3.5 Perception of complexity

- *What makes a risk complex?*
- *Are natural hazards more complex than other risks?*
- *Is complexity perceived at all?*
- *How are different factors of complexity perceived?*

The intensity and frequency of natural hazards are predicted to increase with climate change. The processes leading to climate change are part of a very complex system. Some characteristics of a complex (biological) system are: .

- *a large number of factors and processes*
- *causal networks instead of causality chains*
- *accumulation or reservoirs*
- *lag phases and thresholds*
- *feedback loops (the outcome involves the input in a positive or negative way)*

In complex systems, even simple phenomena are hard to predict since they interact with the system as a whole. The system as whole reacts differently from what may be expected from examining the individual parts of the system. Therefore to know, whether complexity is perceived at all one has to observe the perception not of the individual components, but of the characteristics of the entire system and its interactions.

A system is complex if the causal connections are branched so that instead of linear cause-effect chains we have to deal with networks. The claim of rational analysis in scientific experiments relies on the assumption that experiments can prove causality by isolating stimulus and response and being reproducible independent of location and time. This claim is difficult or even impossible to meet when complex systems (networks) are involved. In complex systems, an event cannot be traced back to a cause, simply because there are different possible causes and many intervening factors.

An example of a very complex system is the process of climate change. As the intensity and frequency of natural hazard events seem to increase with climate change, it will be an advantage to understand the complex interactions between human interventions and reactions in the natural environment. Many individuals have difficulties understanding the nature of complex systems, because even single relations and processes within a complex system are hard to understand, as shown in sections 3.2 – 3.4.

Recent literature shows an example of one characteristic of a complex system, which is very hard to perceive by both lay persons and experts. Sterman (2008) found in a simple experiment, that the accumulation-effect was not seen and understood by 84% of tested people (whether they were scientists or not). He showed the test person a simple picture of the predicted concentration of CO2 in the atmosphere and the actual CO2 emission of the world and asked them to draw a line to show, how the emission has to be changed in order to stabilize the concentration of CO2 in the atmosphere. The majority of the test persons draw a parallel line to the bottom line, which would mean a stable further input of CO2 and would lead to an increase in CO2 concentration in the atmosphere, not to stabilization. “Peoples intuitive understanding of stocks and flows, time delays and feedbacks, is poor” (Sterman, 2008: 533).

The inability of many people to understand accumulation is important because accumulation can have such a significant impact on the system. Plattner (2006) was able to demonstrate that an accumulation of more than one small damaging event interacting with other events could destabilize a society and cause a serious catastrophe. As shown in 3.3 people underestimate events of high probability, which cause little damage, whereas they “like to protect themselves against catastrophes even if they are highly unlikely” (Jaeger et al., 2001: 98). The cumulative effect of small events, which may cause a catastrophe, is not taken into account because most people have difficulties understanding the process of accumulation. Therefore, despite the tendency to protect against catastrophic events, people may not be prepared.

3.6 Perception of uncertainty

- *What are the components of uncertainty?*
- *Is uncertainty perceived?*
- *Is communication of uncertainty necessary, helpful or counterproductive?*

Risks are uncertain events. Therefore risk perception is the perception of uncertainties. There are uncertainties in all levels of risk prognoses: There are different kinds of uncertainties at the technical and methodological level as well as different kinds of uncertainty on the perception level. The only possibility for taking uncertainties into account in risk governance is to provide very transparent information and to have an adaptive, iterative process. So the demands of an uncertain process could be met: to have a certain level of ‘security’, but also to be able to react to changes in the prediction processes.

According to Aven and Renn, 2009, a risk is defined as the “uncertainty about and sensitivity of the consequences (and outcomes) of an activity with respect to something that humans value”. Uncertainty is a superordinate concept, a word which might help to handle lots of different phenomena. Funtowicz and Ravetz (in Kasperson et al. 2001: 177) describe how there are different levels of uncertainty at „the technical, methodological and the epistemological level”. But even the technical uncertainty is loaded with more than one type of uncertainty: Aven (2003) defines uncertainty as a lack of knowledge about the performance of a system and about observable quantities in particular. That means, not only our knowledge (or the lack of it) involves uncertainty but also the observation of the quantities and the quantities itself. Uncertainty therefore exists at a whole range of levels, which have to be looked at in detail when studying the perception of uncertainty.

Funtowicz and Ravetz, (1992) proposed five categories to express the different sorts of uncertainty that affect scientific information (NUSAP): Numeral, Unit, Spread, Assessment, Pedigree. Yet even this differentiation into five categories is not sufficient. For example, in a numerical model, as is commonly used in risk prognosis, the numeral uncertainty or the “uncertainty related to the input parameters“ (Aven, 2003: 16) could itself be the result of a number of factors:

1. “Data are used which are not representative for the actual equipment or event, the data are collected from non-representative operating and environmental conditions etc.
2. The data analysis methods producing the estimates are not adequate
3. Wrong information, perhaps description of the environment
4. Insufficient information, perhaps concerning how to use the equipment
5. Statistical variation, the data base is too small” (Aven, 2003: 16)

Beside these uncertainties of the data collection and parameter choice for a model there is a 6th type of uncertainty in the particular software implementation itself, which could generate false predictions (Koch et al, 2009), for example because of local minima.

There exist a number of techniques to assess the uncertainties at the technical level. These specify a probability for an unobservable quantity or a qualitative estimation for different uncertainty factors (Bell and Glade, 2004). But these techniques are difficult to explain and the experts have little experience in explaining them. In addition to this they may sometimes become mixed up with the probability information of the risk itself (Renn, 2008), Talking about uncertainty in climate change risks is also hard to reconcile with the “media constructions of objectivity, truth and balance” (Smith, 2005: 1471). In addition to this the technical implications of uncertainty are not easy to understand, even by experts from other fields. Therefore ‘uncertainty’ is a ‘black box’ in the perception of risks.

How can this ’lack of knowledge’ by the experts be perceived by lay people as something other than ‘ignorance’? Funtowicz and Ravetz suggest a new methodology, where “uncertainty is not banished but managed and values are not presupposed but made explicit. The model for scientific argument is not a formalized deduction but an interactive dialogue.” (Funtowicz and Ravetz cited in Kasperson and Kasperson 2001: 174). “Theories of deterministic chaos and non-linear systems have provided insights into the uniqueness and instability of global environmental

systems. Contrary to early expectations, these theories do not furnish new tools for knowledge and control on the model of classical physical science, rather than open the way to a new conception of science in which knowledge and ignorance will always interact creatively" (Funtowicz and Ravetz in Kasperson and Kasperson 2001: 177).

3.7 Ambiguity

- *Why can natural hazards be seen as ambiguous? .*
- *How should ambiguous perception be taken into account in risk governance? .*

Natural hazards do not belong to the very ambiguous risk category, such as, for example, newly introduced risks due to genetically modified organisms. But the view on floods, droughts and alpine hazards might differ between regions, social groups or political contexts. Case studies have shown the ambiguities associated with floods: Societies or ecosystems may need regular flooding for nutrification and water supply. Droughts might be necessary for a specific desert vegetation. Therefore in special contexts new forms of deliberative processes could be necessary to appraise the natural hazard.

Compared to technical risks natural hazards are seen as less ambiguous. Axelrod et al. found "the ethically oriented characteristics (i. e. Infringement on rights and ethicality) were more highly correlated with general risks for technologies than for natural hazards." (Axelrod et al., 1999: 43). They also found that the duration of impacts on the ecosystem were seen as less for natural hazards than for technologies but that people did expect less benefit to be derived from natural hazards. Interpretative ambiguity, where people think differently about the underlying values and thresholds, what is regarded as tolerable or acceptable (Renn, 2008) plays some role in flood and drought hazard perception. Floods and droughts are not only catastrophes and harmful but might also have a benefit for the society and the ecosystem. Flooding is a precondition for several ecosystems as in the everglades for example, and also droughts and alpine slides are regular processes needed in special ecosystems to establish and maintain a certain flora and fauna. Interdisciplinary approaches to the natural hazard discussion try to combine implications for single persons and human societies with the view on the ecosystem (Weichselgartner, 2001). When a flood is not seen as fate, but of human origin to a certain degree (see section 3) or when society has had an influence on the flood risk, we have to take ambiguity into account.

3.8 Amplification and attenuation

- *Which factors cause amplification or attenuation of the initial risk?*
- *Are there new risks resulting from amplification of natural hazards perception?*
- *Which models are helpful for understanding amplification and attenuation of natural hazards?*

A risk is changed by the perception of it. People may over- or underestimate risks and communicate this within their social environment. This might result in suppressing a risk or in creating secondary risks, which can be even higher than the original risk itself. The metaphor of amplification is contested, however. Technical models of the amplification of signals are criticised as unrealistic, because the nature of the signal is not changed during amplification or attenuation. Biological amplification systems could perhaps provide a better way to understand the mechanisms of amplification of risks in a society.

The concept of social amplification of risks is a dynamic model that describes the alteration of an initial risk through social interactions in the risk communication process (Kasperson and Kasperson, 1988, Renn, 1991). Amplification and attenuation are visualised by a metaphor from the technical sciences: A feedback loop with an electronic transmitter. However, Rayner (1998: 202) has responded to this concept with the argument that “the electronic imagery is too passive to cope with complexity of human risk behaviour”. Metaphors from other sciences, such as the biological sciences, could address this critique: In physiology we find classical amplification processes such as inflammation. In this situation the body is responding to a signal (for example a bacterial infection) with multiple reactions such as fever, antibody production, cell growth, higher blood pressure. The characteristics of such an amplification system are:

1. Cascades (one signal causes several new signals)
2. Feedback loops (the result of a reaction influences the origin of this reaction, this can be positive or negative)
3. A change of the signal (a stimulus is translated in other signal forms, for example a structural signal as protein structure is translated into an electrical signal and then into a chemical signal)

Whereas the first two characteristics are also seen in a technical transmitter system, the change of the signal seems to be a typical characteristic of the biological metaphor and may therefore help to close the gap between the technical image and the social system of amplification. It is worth noting Rayners comment: “Eventually, anthropologists may realise, that they could describe their subject better through their own concepts, arising out of their own activity of study and participation in a culture” (Rayner, 1998: 203). Biologists have the same problem explaining an ant-colony as a social system. Nevertheless these interdisciplinary analogies are sometimes helpful to sort things out.

Two communication networks play the primary role in risk amplification: the media and the ‘informal personal network’ (Frewer et al., 2002). In Frewer’s study concerning the risks of genetically modified organisms, four factors are mentioned, which trigger the amplification via the media: a large volume of information, disagreement between various actors, dramatisation of risk information and the symbolic connotation. Whether natural hazards are amplified via media according to the same factors remains to be shown. Frewer et al. (2002: 710) found that “the media, in isolation, is unlikely to account for amplification processes described within the social amplification of risk framework”. What remains is the communication via “the informal personal network”. Fewer‘s data on GMO-communication have shown, that amplification via the informal personal network could play a role (which one would also assume for natural hazards): The data “demonstrated that people’s risk perception does increase and decrease in line with what might be expected upon examination of the amplification and attenuation mechanisms integral to the framework” (Frewer et al., 2002: 701).

There is also evidence of amplification from the study of natural hazards. Parker et al. (2009: 106) found that local social networks could be very effective at disseminating and amplifying the reach of flood warnings, “so much so that the better official flood warning systems have learned to make use of these local social networks”. Feedback-loops are characteristics of

amplification systems, usually there is more than one positive feedback in biological systems to stabilize the amplification. In the case of flood warning, often people sought information from more than one source (telephone, internet, local radio, friends, family, neighbours, local authorities and emergency systems). They also passed on flood warning information to others (cascades). The signal is changed not only by the way the information is transferred (radio, personal communication) but also from a first warning, not in any case perceived as a risk, to a consciousness about the coming flood and an awareness or a new behaviour. Other case studies with natural hazards have to be reviewed (and undertaken) to illustrate the amplification process.

In contrast to the amplification of the risk message there may also be an attenuation or reduction in the risk perception. For a long time climate change was a “hidden hazard” and the threat became attenuated or suppressed, because it was “value-threatening” and an “ideological hazard” (Lorenzoni et al., 2005, Kasperson and Kasperson, 1991). Poumadére et al. (2005, 1483) report the profile of the heat wave in France 2003 “as a strongly attenuated risk” with a “sudden shift into amplification”. “As the public health catastrophe became undeniable, the heat wave emerged as a here-and-now example of dangerous climate, hitherto denied in the French context”. There is a wide variety of serious impacts from climate change on health, farming, forestry, economy, water and energy supply, and technological operations, but “their full extent and their systemic interaction remain unknown” (Poumadére et al., 2005: 1492). The social amplification concept could help us to understand how a social system responds to an initial risk and how different impacts of natural hazards are connected and are reacting at every step, so that a new type of risk is evolving.

3.9 Trust

- *In what or whom do persons trust when concerned about a risk?*
- *How does trust influence the perception of risks?*

Trust in communicators, experts and decision makers seem to be an important factor in risk perception in general and of natural hazards in particular. But the factors, which lead to an increase in trust differ. More case studies are needed.

Trust is an important factor of risk perception and becomes even more important, when the individuals knowledge about the hazard is low. Siegrist and Cvetkovich (2000), working with different, mainly technological risks, were able to prove the hypothesis, that self-knowledge mediates the influence of social trust in authorities. And the more people knew about a risk the more they trusted in their own personal judgment and not in the advice of the authorities. This has to be borne in mind when looking for competent and transparent communication of the risk by experts.

There seems to be a strong relationship between the uncertainty of the risk and the role of trust (Frewer and Salter, 2007). Paton (2008) argues that trust only becomes necessary when there is potential or actual risk to the decision maker. Of course when dealing with natural hazards, all decision makers have to deal with risk and uncertainty. In this situation “trust functions to reduce the uncertainty and complexity that people encounter when faced with novel events …” (Paton 2008: 4). Trust then becomes “a construct of considerable importance when dealing with unfamiliar, infrequent and complex environmental hazards” (Paton 2008:4). Paton`s

studies of bushfires, earthquakes, volcanic eruptions and floods show that “when dealing with infrequently-occurring natural hazards, information will be evaluated in terms of peoples’ generalized beliefs regarding trust in the social institutions providing information”. But as we have shown in 3.6, we have to look to the different origins of uncertainty in detail, a view that is also reflected in lay persons’ perception: “Lay people do distinguish between different kinds of uncertainty”...“Indeed, the public appears to be more accepting of uncertainty resulting from inadequacies in scientific process than to uncertainty associated with the failure of institutions to reduce scientific uncertainty through conducting appropriate empirical investigation” (Frewer and Salter, 2007: 153).

Other factors influencing trust are personal beliefs and values. Also the social representations of ’home’, ‘nature’ and ‘society’ seem to be important, as Harries (2008; 479) has found in his study of flood risk areas in England. Even at-risk residents want to see their homes as safe, and nature as a “positive moral force” and “society as a competent protector”. They defend their social representations by “avoiding perceptual shifts and behaviours that might challenge them”. In this case trust in the authorities was counterproductive as people were expecting the authorities to prevent them from flooding. Trust therefore delayed or inhibited residents from taking measures against flooding.

4 Mapping risk perception factors of natural hazards in Europe: an overview of the current literature

Risk perception depends on many factors, some of which have been discussed in detail in section 3. As natural hazards vary, ranging from sudden events such as flash floods to long lasting and slowly developing dangers such as droughts, so do risk perception studies. Only a few studies draw valid comparisons across the whole range of natural hazards. In addition, these studies differ in approach and test design. In this section, we collected around 30 risk perception studies from Europe that were conducted over the last decade (see Annex A). Most of the studies focus on floods, some include avalanches, mud slides, volcanic risks and heat waves. All the papers investigated different factors that may affect people's perceptions of the risks arising from natural hazards.

In the studies listed in the reviewed papers the following risk perception factors were explored:

1. **Risk factors**: perceived likelihood of an event, perceived or experienced frequency of hazardous event
2. **Informational factors**: source and level of information, media coverage, involvement of experts in risk management
3. **Personal factors:** age, gender, educational level, profession, stakeholder membership, personal knowledge, personal disaster experience, trust in authorities, trust in experts, confidence in different risk reduction measures, involvement in cleaning up after a disaster, feelings associated with previously experienced floods, world views, degree of control, religiousness
4. **Context factors:** economic factors, vulnerability indices, home ownership, family status, country, area of living, closeness to the waterfront, size of community, age of the youngest child

Annex A lists and briefly describes the main insights that can be gained from these studies. Although the limited number of 30 studies does not allow representative inferences, it is sufficient to explore the most important factors and to discuss their significance for risk perception.

1. **Risk factors** do not play a very important role in the risk perception of natural hazards (Heitz et al., 2009). The likelihood of a disaster is barely taken into account when making judgments about perceived risk levels (Miceli et al., 2008). Possible reasons for this underestimation of likelihood have been already discussed in section 3. The perceived magnitude of a disaster is also of little importance for people's risk perception (Haimes, 2004, see section 3). This is surprising since catastrophic potential is a rather strong predictor for risk perception in the field of technological risks (Slovic 1987).
2. **Informational factors:** The type and source of **information** has been shown to have a significant though low impact on risk perception. However, much of this impact could be explained by the differences in perceived trustworthiness of authorities providing the information (Heitz et al., 2009). Information provided by the mass **media** shapes risk perception to some degree (see section 3.4) but if persons report that they have had personal experience with hazards, media coverage does not play a major role (Siegrist

and Gutscher, 2006). However, media reports about an expected flood can stimulate people to recall the previous experience of a flood event (Felgentreff, 2003).

3. Most of the **personal factors** tested in the studies show little to no significant influence on risk perception. In some studies there were weak but significant correlations between risk perception and selected personal characteristics, such as **age**: People aged under 25 and over 45 underestimated the danger of flash floods inundating a specific road section (Ruin, et al., 2007). In another study, younger people perceived the risks of flood as being more serious than older people (Miceli et al., 2008). However, most studies did not find any age-dependency (Barberi et al., 2008, Siegrist et al, 2006, Grothmann et al., 2006, Sjöberg et al., 2000).

   A similarly ambiguous situation exists with regard to **gender** (Barberi et al., 2008, Plapp et al., 2006, Grothmann et al., 2006). Women rate flood risk as more serious than men (Miceli et al., 2008). They also seem to be more worried about volcanic risks (Barberi et al., 2008). However, when these effects were controlled for hazard-experience (see b) gender did not make any difference. Lastly, the **educational level of the respondents** had hardly any influence on risk perception (Miceli et al., 2008, Plapp and Werner, 2006, Armas, 2008, Barberi et al., 2009).

   Several studies were able to demonstrate that experience is a significant and strong predictor for risk perception (Plapp and Werner, 2006, Felgentreff, 2003, Grothmann et al., 2006, Miceli et al., 2008, Terpstra, 2009, Heitz et al., 2009, Siegrist et al., 2006). In the study by Plapp and Werner (2006), personal experience proved to be the most influential factor among many other tested (for a detailed discussion of experience and expertness see section 3.1).

   Some studies explored “flood experience” in more detail (Terpstra, 2009, Miceli et al., 2008): Positive or negative **feelings associated with personal flood experience** were found to have different effects on perception and preparedness intention (Terpstra, 2009): Negative feelings associated with previous experience decrease trust in official flood protection measures and increase risk perceptions, positive feelings increase trust in authorities and decrease risk perception. An Italian study revealed a correlation between feelings of worry and the adoption of protective behaviour (Miceli et al., 2008). However, the longer the time distance between the experienced event and the time of the interview, the less pronounced the effect. Risk perception and risk awareness reach high levels directly after a flood event, but soon fade away over time and approximate average levels. It seems to be essential to help people recall the experience of the flood if one wants to motivate them to take protective actions against a new flood (Felgentreff, 2003).

   In addition to personal experience, the second most important factor for the risk perception of natural hazards seems to be **trust** in authorities and confidence in protective measures (Terpstra, 20009, Armas, 2009, Heitz et al., 2009, Barnes, 2002). The influence of trust on risk perception (see section 3.9) has been extensively studied in the context of risk preparedness. Trust in flood protection, for example, lessens perceptions of flood likelihood and magnitude and, through this route, reduces intentions to prepare for floods (Terpstra, 20009). These results from the Netherlands can be compared to the results from a flood-study in Romania, where the lack of resources and mistrust in authorities reinforces non-adaptive behaviours (Armas, 2009). These different

effects of trust on risk preparedness as shown in the two studies may be due to differences in political culture and different experience with authorities in general.

4. **Context factors** are routinely investigated but they are often conflated with personal factors. For example, personal flood experience is often documented as an intervening variable for explaining regional differences in flood risk perception (Ruin et al., 2007, Kaiser et al., 2004, Siegrist et al., 2008). Many studies show that the perception of flood risks depends on the place of residence (areas with frequent floods versus rare floods) (Brilly and Polic, 2005; for muddy floods see Heitz et al., 2009).

   Economic factors do not seem to play a significant role in risk perception, with the exception of **home ownership.** Grothmann was able to show that perceived economic impacts had little influence on risk perception as well as on the willingness to take precautionary measures. The only economic variable that had an influence on both outcomes (perception and willingness) was home ownership. The most powerful predictor was again recent exposure to a flood (Grothmann et al., 2006).

Many open questions remain where further research is warranted. Our analysis of the 30 studies points to the importance of two major variables: experience of hazardous events in the past and trust in experts and authorities. Of minor but still significant importance are house ownership and media coverage. These insights can be used for both risk communication and risk governance. Section 6 and part III of this report will discuss the possible implications and articulate some recommendations. Two additional aspects should be mentioned here as they touch upon governance and communication:

The perception of flood events has been found to change after participation processes (Stanghellini and Collentine, 2008, Slinger et al., 2007). Research indicates that people become more aware of floods and are more motivated to initiate protective action if they are involved in a participatory exercise. This seems mainly due to a shift towards more trust in the authorities and the experts. As a result of successful participation exercises, the public and the scientists were willing to learn from each other and to adjust their perceptions and behaviour once they were confronted with reliable information on exposure, consequences and protective measures. Another effect of the participatory workshops was that the citizens were less focused on technical measures and indicated that they wished policy makers to spread their attention more evenly over the full range of flood risk management measures including stricter zoning and building flood reservoirs and polders (Slinger et al., 2007).

Another important insight for risk governance is the fact that natural hazards tend to be rated lower on the perceived level of risk than, for example, technological risks (Plapp and Werner, 2006, see also sections 2 and 3). “Tampering with nature” was the strongest predictor of perceived risk in a perception study comparing different risks from natural and technological sources (Sjöberg, 2000). In recent years, floods are increasingly perceived as “human-induced” rather than an act of God or Nature. People tend more and more to believe that the extent of damage as well as the frequency of disasters are caused or at least amplified by human actions such as interventions into the climate or redirecting rivers. As a result natural hazards could face

the same kind of patterns that characterize the perception of technological hazards (Deeming *et al.* forthcoming)[2]. The study by Baan et al. (2004) reports a possible change in the perception of floods, which occurred as a result of a discussion on intentionally inundating calamity polders to protect more downstream areas. If floods are associated with human actions it has major repercussions for risk governance, since social institutions will be blamed not only for inadequate response and emergency measures (as in the past) but also for the severity or frequency of the disasters themselves (see section 6).

[2] Deeming, H., Whittle, R. and Medd, W. (under review) "Investigating resilience through 'before' and 'after' perspectives on residual risk" Book chapter for “Innovative thinking in risk, crisis and disaster management”. Bennett, S. (ed.) Aldershot, Ashgate

5 The relevance of risk perception for social capacity building: Case studies and best practice examples

The following section has three case studies which examine some of the issues discussed above in more detail. The first, from Germany, looks at the impact of a major flood event on the perception of risk and of various precautionary measures. The second, from the Metropolitan Region of Barcelona in Spain, examines risk awareness and responses to drought. The third, from Italy, focuses on people's judgments, attitudes and opinions regarding the alpine hazards of flooding and debris flows.

5.1 Floods

Risk perception and precautionary measures. The example of the 2002 Mulde flood (Germany)

1. The following case study explores residents' perception of flood risk both before and after a major flood event. It examines the factors influencing risk perception and the perception of the usefulness of and responsibility for different protection and mitigation measures, both public and private. The public/private distinction proved significant with residents taking a critical stance to the suggested increase in private flood responsibility.
2. In 2002, a major flood occurred in the Central European river basin of the Elbe and affected a number of tributaries and territories in Germany and the Czech Republic. Among them there was also the Vereinigte Mulde River in Saxony, Germany. In 2004 we started to investigate the social dimensions of the Mulde 2002 flood within the frame of the FP6 Integrated Project FLOODsite.3 Referring to the description of the institutional framework conditions in the Mulde region (as a contribution to CapHaz-Net's WP2 report; Walker et al. 2009: 38–43) as well as concentrating on social vulnerability (as a contribution to CapHaz-Net's WP 4 report; Tapsell et al. 2010; for the detailed analysis see Steinführer and Kuhlicke 2007 and, with a focus on surprise and ignorance: Kuhlicke 2008), this empirical example refers to how people perceive the risk of flooding.
3. The paper is structured as follows: In the first section, we will outline our understanding of risk perception and draw the methodological implications on how to approach it. In the second section we describe our research design. The third section presents the main findings from the case study. The fourth section summarises the insights and draws theoretical and methodological implications.

Our approach to risk perception and research design

In the aforementioned project, we, firstly, investigated how people perceive the risk of being flooded and how this perception changed through the 2002 flood event and, secondly, how people perceive the responsibility for different protection and precautionary measures. Our major

[3] The work described in this section is based upon our contribution to FLOODsite's Task 11 between 2004 and 2009. There we conducted comparative case studies in Germany, Italy and the U.K. (Steinführer et al. 2009). This work gained much inspiration from the cooperation with Bruna De Marchi and Anna Scolobig (ISIG) as well as with Sue Tapsell, Sylvia Tunstall, Amalia Fernandez-Bilbao and Colin Green (FHRC). FLOODsite – "Integrated Flood Risk Analysis and Management Methodologies" – was funded by the European Community's Sixth Framework Program (contract GOCE-CT-2004-505420; http://www.floodsite.net).

interest was the question how risk perception influences the application of private precautionary measures.

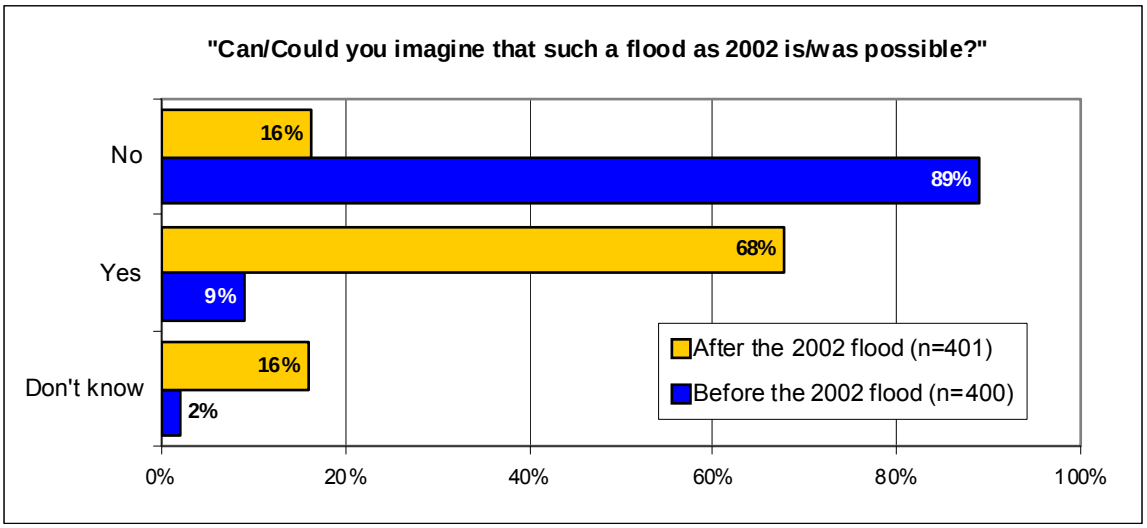
The research was carried out in 2005/2006 in three locations in the Saxon section of the Vereinigte Mulde River: the village of Sermuth (population 600 in 2005), the village of Erlln (population 90 in 2005) and the small town of Eilenburg (population of around 17,500 in 2005). All of these settlements were heavily affected by the Elbe flood in August 2002 and in each of them evacuations occurred.

The major way of data gathering was by way of a standardised questionnaire survey which was carried out in December 2005, i.e. more than three years after the event. For the questionnaire survey we a applied research design that consists of a self-administered survey with some elements of face-to-face interviews and postal surveys. 404 respondents were our prime source of information, along with 22 in-depth interviews with stakeholders and affected residents.

Main findings of the "Vereinigte Mulde" case study

Perception of flood risk

Almost 90% of the respondents could not imagine that a flood like the one in 2002 could threaten them. This proportion changed drastically after the flood. The majority of people, namely almost 70%, now can indeed imagine that such a "bad" or an even "worse" event could occur again in the respective area (Figure 5.1).



Source: FLOODsite survey 2005

Figure 5.1: Perception of flood risk before and after the 2002 flood

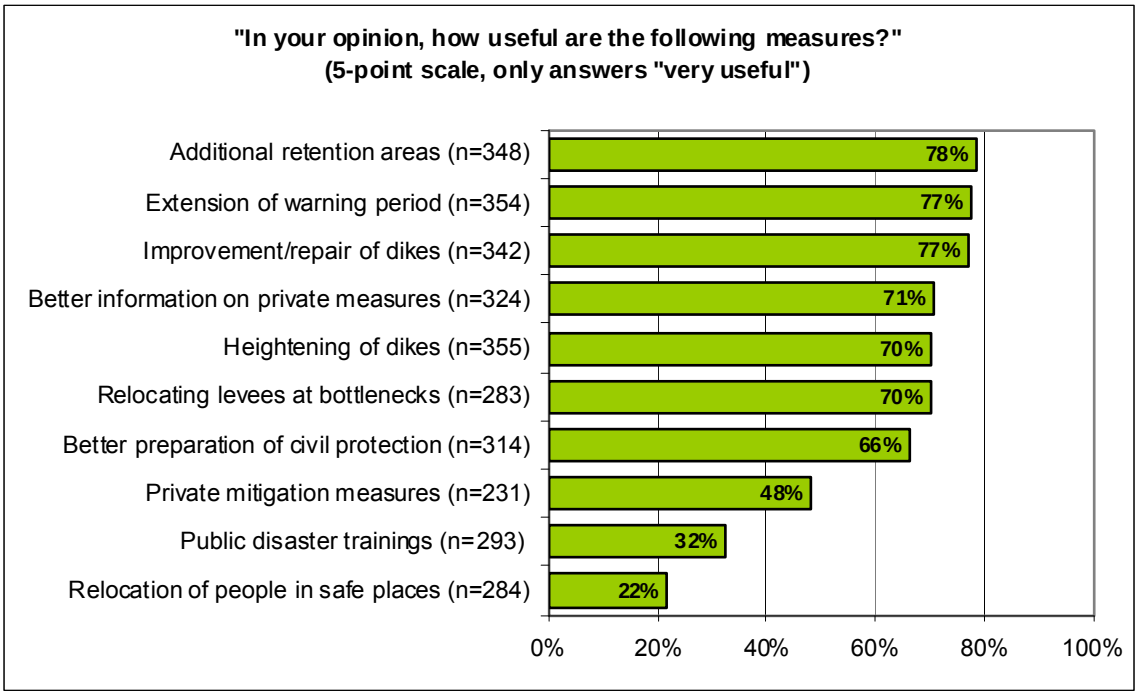
While the imagination before the flood is not significantly influenced by any of the independent variables (such as age, gender, education or tenure), the judgement about the recurrence of a similar or a even worse flood is above all a question of age: People who can imagine that such an event might happen again are on average 54 years old, while the opposite group is aged 64 ($p<0.001$; T-test). For elderly persons the probability of a reoccurrence is rated lower, possibly

because the question is not understood as an abstract experiment. They rather seem to directly connect the question to the available lifespan they attribute to themselves (“during my lifetime”).

Our hypothesis that risk perception influences the application of precautionary measures could be verified to the extent that respondents who perceive the recurrence of an event like the 2002 flood as likely applied more precautionary measures after the 2002 flood than those who do not evaluate the recurrence as likely ($p<0.05$, 2-sided; $p<0.01$, 1-sided; Fisher’s Exact test).

Perception of usefulness of and responsibility for different protection and mitigation measures

To start with, in the questionnaire we introduced a list of different measures to people and asked them to indicate the degree to which they thought these measures were useful or not. From Fig. 4.2 it becomes apparent, that most proposed measures were rated as very useful, irrespective of their “structural” or “non-structural” character (for a detailed discussion of this distinction: Olfert and Schanze, 2007). However, it is also striking that measures based on individual actions (like private mitigation measures and public disaster drills), are rated as least useful. We interpret this as a first sign for our hypothesis that the people at risk do not necessarily share the responsibility the new paradigm of flood risk management attributes to them.



Source: FLOODsite survey 2005

Figure 5.2: Usefulness of different measures

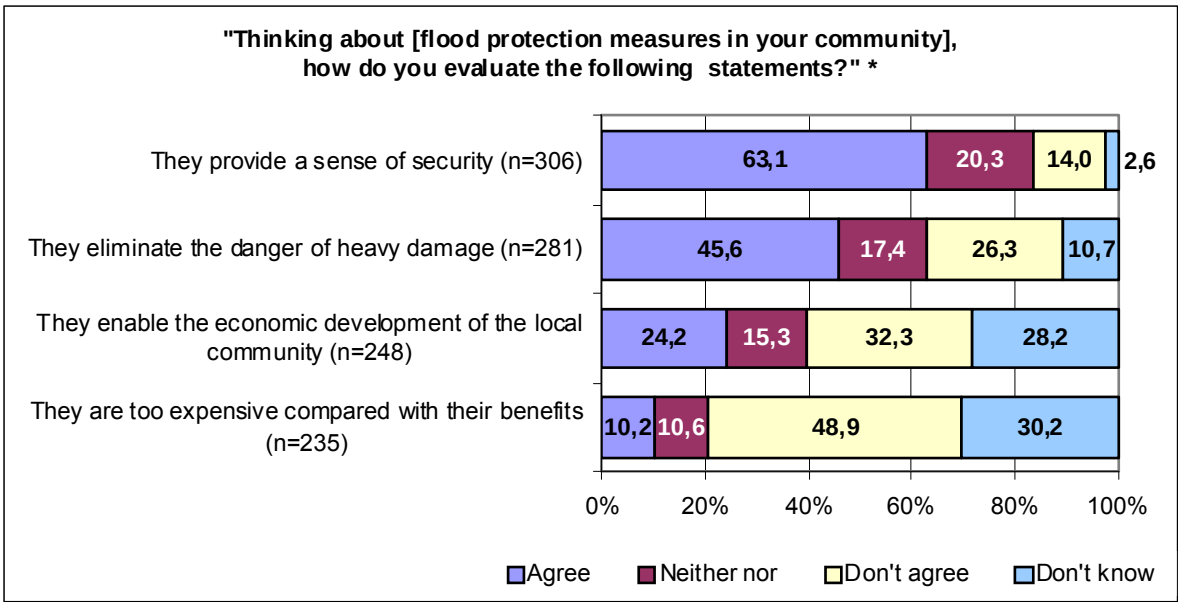
Yet, the high ranks of an “extension of the warning period” and “additional retention areas” are to a certain extent surprising. However, the general approval to “extend the warning period” has to be read as a strong criticism of the public warning and evacuation procedure before the 2002 flood. The superior rank of “additional retention areas” could be read as a signal that no longer solely technical protection measures are preferred. However, we are more inclined to another interpretation: that is that the people at risk in the Mulde floodplains do not distinguish between

the different types of measures as “flood experts” (be it managers or scientists) usually do. This is substantiated by the fact that among the measures regarded as most useful all technical (“traditional”) flood protection measures are also included. Rather, the respondents draw a clear line between “public and private” measures, and therefore of personal and public responsibilities (see below).

First of all, there is a high degree of unanimity with respect to the repair of dikes. Irrespective of their social background, people regard this measure as highly useful. Secondly, formal education matters with respect to dike heightening. People with a high formal education define this activity as less useful, while the opposite group is much more convinced of their relevance for flood protection (but only weak correlation: Spearman’s Rho -0.22; $p<0.001$).

As for private mitigation measures, the picture is different. They are regarded as “useful”, which, however, in comparison with most other measures means that they are not understood as “very useful”. People seem to have their doubts about the actual relevance of private measures. Most critical towards such measures are people with a high level of formal education, qualified workers and white-collar employees with a higher position (partly overlapping). Hence the emerging picture is ambiguous, there is no linear relation between socio-economic status and the meaning attributed to private mitigation measures, as might have been expected. Tenure does not matter, both renters and owner-occupiers regard private mitigation measures in their majority as “useful” but not “very useful”.

A similar picture emerges when considering attitudes towards public protection measures. First of all, there is a high degree of unanimity in favour of the sense of security and damage reduction these structural devices provide (Figure 5.3). But, secondly, uncertainty is high specifically with regard to the actual efficiency of these measures: 30% don’t feel able to judge whether the costs for their construction and maintenance are justified or not compared with the benefits. However, almost every second respondent refuses the statement that dikes and the like are too expensive. Finally, a closer look at certain social groups reveals that in particular formal qualification and age are crucial for interpreting these assessments: The better educated and the younger are much more sceptical with regard to the actual capabilities of public protection measures than people with lower degrees of formal education and, partly overlapping with the first group, the elderly.



* Original scale (1–5) merged to 3 categories. Source: FLOODsite survey 2005

Figure 5.3: Attitudes towards public protection measures

Moreover, we wanted to better understand the motivations for applying precautionary measures. To find out what people think about the meaningfulness and usefulness of private precautionary measures as increasingly demanded by Flood Risk Management approaches, we did not ask them directly but formulated a question about the new Saxon Water Law in the following phrasing: “The new Water Law of Saxony will include the phrase: ‘Everybody who is prone to flood hazards is obliged to implement mitigation measures in accordance with his possibilities and abilities’. Do you think that this law is reasonable?” The reason for doing so was threefold: Firstly, pre-survey interviews and the pilot phase of the questionnaire survey showed that many people living in floodplains were not aware of the existence of the law. Secondly, it seemed more promising to ask a question which is directly linked to the real lives of the people in the sense that the law addresses the respondents directly instead of asking an abstract thought experiment. Thirdly, most people do not understand the very concept of private precautionary measures, as many interviews and the pre-test showed. This, by the way, is already a remarkable result in our opinion.

The majority of people (40%) regard this law as not reasonable, 27% think the opposite, and 32% could not answer the question (n=371). These figures are a further hint indicating that the often claimed necessity of private precautionary measures is not accepted without restrictions by the population at risk. There are no significant differences among the tested socio-economic variables, except that owner-occupiers are more inclined to evaluate the new law as not reasonable than renters ($p<0.01$; Chi-square test). Hence, those potentially more likely to have to implement and finance such measures are also most critical about the new law. However, it seems important to point out that people who think this law is reasonable and thus—more or less—agree with the demand to mitigate damages by private precautionary measures, significantly more often applied such measures (Table 5.1).

Table 5.1: **"Do you think that [the new Saxon Water Law] is reasonable?" (by application of precautionary measures; n=238)**

	Applied precautionary measures	Applied no precautionary measures
New law useful (n=99)	54%	46%
New law not useful (n=139)	35%	65%

(p<0.01; Chi-square test)

Source: FLOODsite survey 2005

A closer look at the reasons for the answers (open question) indicates a quite diverse picture about people's judgements concerning the usefulness of the newly introduced law (Table 5.2).

Table 5.2: **Comments on Saxon Water Law (n=372; multiple answers possible, categorised ex post)**

"Please explain why you think the new Saxon 'Water Law' is, or is not, reasonable."	
(a) No, not reasonable (n=152; answers=168)	
The single citizen is unable to do anything	27
Don't know what to do	18
Flood protection is a public duty	17
Definition is imprecise (disadvantages for the citizen)	17
Is a matter of course/ the duty of every citizen	13
Too expensive for many citizens	9
Natural events are not predictable/avoidable	7
Problems/guilt are/is to be found elsewhere	6
As a consequence people must move away/population will decline	3
Unreasonable demand	2
…, but new constructions should be prohibited	2
Others	5
No reason mentioned	42
(b) Yes, reasonable (n=103; answers=108)	
Some things you can do by yourself (sand bags, furniture, securing property) things)	19
It is the responsibility/in the interest of the citizen	16
Insurances are important	7
Everyone should contribute	6
If you live in a floodplain, you should be aware of it	3
During the reconstruction you should apply precautionary measures	2

"Please explain why you think the new Saxon 'Water Law' is, or is not, reasonable."	
In this area construction should be prohibited	2
…, but better warnings are necessary	7
…, but better information about precautionary measures are necessary	2
…, but what does "in accordance with his abilities" mean?	1
…, but elderly and handicapped people should be excluded	1
…, but the endangered area should be displayed more precisely	1
…, but how to control the law?	1
Others	11
No reason mentioned	29
(c) "Don't know" (n=121; answers=123)	
Definition is imprecise (disadvantages for the citizen)	9
The single citizen is unable to do anything	5
Is a matter of course/ the duty of every citizen	3
Problems/guilt is to be found elsewhere	3
State displayed building land	2
Natural events are not predictable/avoidable	1
Warning in time more important	1
Don't know what to do	1
Information more important	1
No reason mentioned	97
No answer (n=32)	

Source: FLOODsite survey 2005

In order to get a more nuanced picture, we further compiled the answers in the following three categories, regardless of whether the respondents agreed with the law or not. Also the reasons for answering "don't know" were considered:

- Answers pointing to an excessive demand (overload) of the individual, either because of missing information, knowledge or resources (such as "don't know what to do", "cannot do anything", "natural events are not predictable/avoidable", "too expensive", "people must move away", "problems/guilt are/is to be found elsewhere", and "unreasonable demand");
- Answers taking such an approach as a matter of course, hence regarding flood protection not exclusively, but also as a private task (mainly "is a matter of course/the duty of every citizen", "it is the responsibility/ in the interest of the citizen", "insurance is important", "everyone should contribute", "if you live in a floodplain, you should be aware of it", as well as "during the reconstruction you should apply precautionary measures"),

- Answers underlining that flood protection is understood not as duty of the individual but rather as a public responsibility (e.g. “flood protection is a public duty”, “warning is more important”, or “information is more important”).

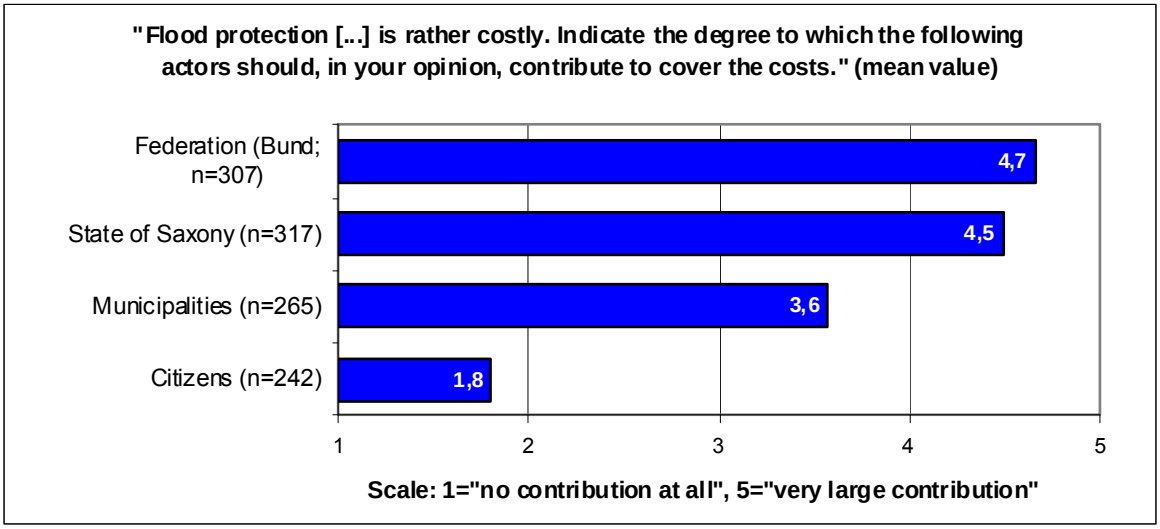
This typology follows the hypothesis of a “**privatization of risk**”. In this view flood protection is no longer a public duty, but in some parts increasingly to be regarded as a task for the individual. Therefore we developed a typology trying to categorise the answers with regard to this privatization of risk. Table 5.3 shows that the majority understands the new flood management requirements as something going beyond the individual’s responsibility. The detailed answers point to the problems that some people are either not financially in the required position, that they do not know what to do or do not see any possibility to mitigate the impact of a flood. 11% of the respondents answering this question explicitly regard flood protection as a public duty, while 35% find it self-evident that people living in floodplains have to contribute to flood protection.

Table 5.3: Opinions about new Saxon Water Law (by answer categories; n=133)

	New law reasonable (n=34)	New law not reasonable (n=87)	Don’t know (n=12)	All (n=133)
Flood protection: excessive demand (overload) of citizens	–	71%	83%	54%
Flood protection: also citizens’ task	100%	14%	8%	35%
Flood protection: public responsibility	–	15%	8%	11%

Source: FLOODsite survey 2005

These findings are supported by Fig. 4.4, which presents a rather predictable result: most respondents expect the financial burden of flood protection measures to be carried by public authorities, in the first instance by state organisations. The further “away”, the higher the contribution should be. However, the respective numbers of valid cases (n) also indicate that there is considerable uncertainty about these issues in the population. The answers did not reveal any significant differences with regard to the application of precautionary measures. Out of the tested socio-economic variables, only tenure needs to be mentioned: Owner-occupiers ascribe a significantly lower financial contribution to the citizens in flood-prone areas than renters ($p<0.01$; T-test).



Source: FLOODsite survey 2005

Figure 5.4: Cost distribution for flood protection in the residents' perception

Conclusion and implications

The perception of the risk of being flooded changed considerably in the course of the 2002 flood. Approximately three and a half years after the flood, this risk of being flooded is taken much more seriously than before.

The appraisal of local and regional structural measures, their efficiency and benefits is very high. The residents at risk don't refuse non-structural measures such as land use changes, at least as long as they are not affected by such measures themselves (for example public flood drills and simulations). This could be interpreted as a sign of the NIMBY phenomenon ("not in my backyard"). However, the distinction between structural and non-structural measures which is regularly made by flood "experts" proved to be not meaningful for the respondents—but highly meaningful in their perceptions is the dividing line between public and private responsibility.

This has implications for the much discussed paradigm shift "from flood protection to flood risk management" which will mean significantly greater responsibility for the individual. Generally, our empirical results point out that most respondents have a critical stance towards such a privatization of risk. In the survey, we used the example of the new Water Law, which was passed in Saxony in 2004 and in a similar phrasing by the German Bundestag in 2005. The majority of answers understand these new legal regulations as an excessive demand (overload) for the citizens living in the floodplains. However, the hypothesis with regard to the perception of usefulness, information and responsibility and their respective role for the application of precautionary measures could not be verified. Whether people apply precautionary measures or not seems to be relatively independent of the degree of information, the perception of usefulness and responsibility. Only the question regarding the meaningfulness of the new Water Law revealed significant differences: Respondents who support the law more often applied precautionary measures.

5.2 Droughts

Citizens' risk awareness and responses to the 2007-2008 drought episode in the Metropolitan Region of Barcelona (MRB)

Laia Domènech, Meera Supranamiam and David Saurí

Introduction

A drought may be defined as the temporal lack of water caused necessarily but not exclusively by an abnormal climatic situation which may affect negatively the population, the economic activities and the environment (Kallis, 2008). In 2007-2008 the Metropolitan Region of Barcelona (MRB) suffered an acute drought that threatened the availability of drinking water. According to records of the last 60 years, the precipitation deficit was the worst registered to date. Besides precipitation deficits, the urbanization process also appears as a factor responsible for the occurrence of drought episodes. Around five million people live in the MRB where domestic consumption accounts for nearly 70% of the total water demand. Furthermore, the ever-increasing suburbanization process creates new uses of water such as irrigation of private gardens and swimming pools which demand important volumes of the resource. Coupled, these natural and social factors are conducive to droughts.

The drought period began in early 2007. In February that year the first awareness campaign with the message "In order to have water, close the tap" was launched to promote domestic water savings. Furthermore, the government approved a drought decree in April 2007 which mandated the adoption of a series of exceptional measures to stimulate water savings. In August 2007, the inner basins of Catalonia entered the stage of exceptionality I, as reservoirs fell at 40.5% of their capacity.

As the situation was far from improving, in 2008 the government launched another public campaign that entailed the distribution of more than 650.000 water saving kits given away for free with the Sunday papers. In February 2008, reservoirs attained 22.3% of their capacity which resulted in the declaration of the stage of exceptionality II. This status involved the prohibition of using drinking water for secondary uses such as the irrigation of public and private gardens, parks and orchards, street cleaning, public and private swimming pools and fountains and car washing with a hose. The potential adoption of domestic water cuts in autumn loomed on the horizon. A wide range of urgent measures such as the transportation of water by sea tankers, the transfer of water from the Ebro and the Segre rivers were proposed to avoid domestic water cuts which would have borne an enormous political cost. As the effects of drought were intensifying, in March 2008 another public campaign with the message "Together we can confront drought" was launched in the press, the radio and the television. At the end of March water reservoirs registered their minimum level at 21% of their capacity which was extremely close to the emergency level.

Information about the state of the water reservoirs in Catalonia was present everyday in the mass media and abundant publicity was issued about the urgent situation of the country and the measures adopted by the government. An important and crucial debate was opened around the need to increase the availability of water supplies in the Barcelona area. Confrontations between different political parties as a result of their differences regarding water management were also commonplace. This milieu had a direct impact on the citizens' perception of the

situation as shown by the Catalan Official Barometer of April 2008. Water scarcity escalated for the first time in democratic history to become the first concern of Catalan citizens while immigration and housing access where in second and third positions.

In April and May 2008 it started raining and reservoirs slowly approached again their normal conditions, so that restrictions were softened. However, total normality was not reached until January 2009 when the drought decree was lifted. The total cost of the drought amounted to 490 millions of euro, among which 389 millions were spent to enlarge the desalination plant at the Tordera river basin, 64 millions to recuperate abandoned wells and 17.7 millions to transport water by boat.

Important water savings were registered during the drought period due to the restrictions adopted and the positive response of the citizens. Around 33 hm^3 were saved in the Ter-Llobregat system and in the last week of June 2008 water consumption dropped 21% with respect to the average water consumption of that period. For further details of the drought in Barcelona, please refer to the case studies on drought in Barcelona in the WP2 (Risk Governance) and WP5 (Risk Communication) reports (Walker et al. 2010, Höppner et al. 2010).

Aims and objectives

Taking as a case study the 2007-2008 episode in Barcelona, this paper aims to analyse how citizens perceive the risk of droughts, and what kind of management options they prefer. More specifically, the paper focuses on three main issues that are examined through more concise survey questions:

a. The level of citizen concern towards droughts. We approach this issue by studying the significance that residents gave to the 2007-2008 episode and the citizens' vision of future difficulties to meet water demand
b. The citizens' response to the drought. Here we analysed citizens' behaviour before, during and after the drought
c. The level of citizens' awareness and their opinion about the measures promoted by the government to enhance the resilience capacity of the region against droughts. Here the survey questions focused on citizens' willingness to support drought management measures.

Methodology

A survey of 437 households was carried out in the Metropolitan Area of Barcelona (MAB) in November 2009. The MAB is an administrative entity with 36 municipalities which share the management of some services such as transportation, waste management, water supply and sanitation. The sample was stratified according to housing types: thus 89% of the surveyed lived in apartment buildings, 5% in apartment buildings with a common garden area and 6% in single family houses.

It was carried out by telephone and included a number of questions to measure the perception of citizens towards the drought of 2007-2008. Respondents were asked to give their opinion about the seriousness of the drought, its causes and future scenarios regarding water availability in the MAB. Citizens' knowledge and opinions about the measures adopted by the

administration, and their behaviour during the drought were also analysed. Socioeconomic variables such as gender, age, income, education and type of building were also included in the survey in order to establish correlations with citizens' perceptions.

This is compared with another survey that was carried out between November 2008 and January 2009, which was a short time after the same drought of 2007-2008, in the town of Matadepera which is a high income suburban area of Barcelona. All 69 respondents in Matadepera, lived in single family households with private gardens and other outdoor uses that demand high volumes of water. This household type differs to the first survey mentioned, and were especially affected by the water restrictions imposed during the drought and for these reasons, it was particularly interesting to analyse their behaviour during this period.

Finally, another survey among 400 people from the municipality of Sabadell (a major city of the Metropolitan Region of Barcelona) (Romeu, 2008) was used as a comparison of the opinions of citizens on the drought management measures adopted by the government. . In this case, citizens were surveyed about their preference towards different water supply sources between May and June 2008, i.e. during the drought.

Data about water consumption obtained from the secondary sources has also been analysed in order to contrast water consumption records with some of the findings of the survey.

Results

Level of citizens' concern

Most citizens (91.5%) were aware that in 2008 there was a situation of water scarcity in Catalonia. In addition, most people felt well informed about the drought situation (Figure 5.5). Both results are consistent with the impact that the drought scored in the media and accordingly, with the large volume of information available.

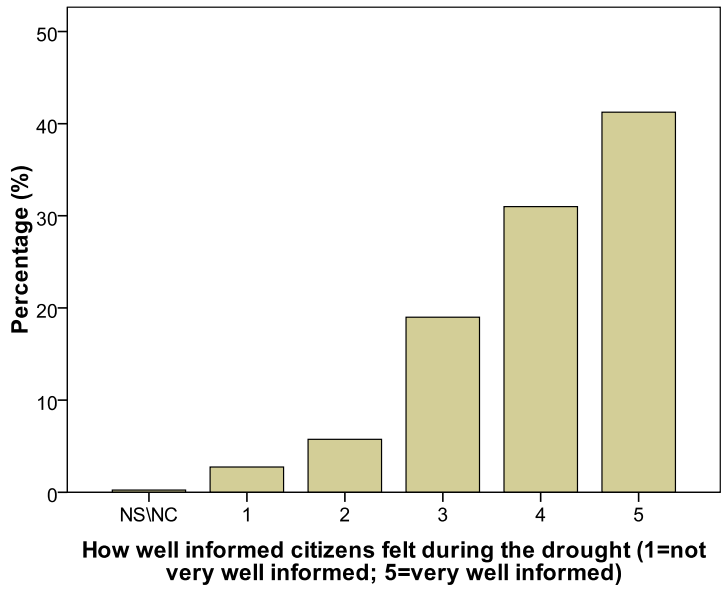


Figure 5.5: **Perception about how well informed respondents felt during the drought.**

The citizens' appreciation of the seriousness of the drought reflects the high degree of concern that the drought created among the Barcelonean society. Most citizens interviewed considered that the drought had been very serious (44.2%) or serious (31.5%). Significant differences regarding this perception are found between women and men. Women perceived the drought as having been more acute than men ($p<0.01$, Mann-Whitney, Figure 5.6).

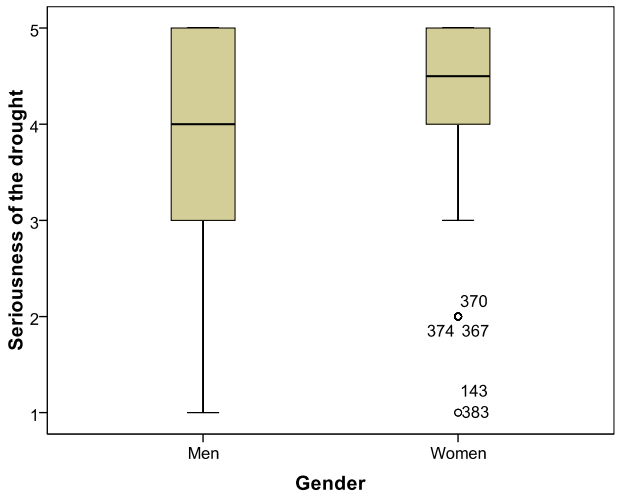


Figure 5.6: **Perception of the seriousness of the drought, as expressed by the residents of the MAB.**

Regarding the citizens' perception about the difficulties to meet the water needs of Catalonia in the future, opinion was quite divided: 37.1% believed that there will be no difficulties to meet the water needs of the next 10 years, 32% believed that there will be difficulties and 27.7% thought that this issue remains highly uncertain (Figure 5.7). From these results it can be extrapolated that more than half of the citizens are worried about drought vulnerability in the Barcelona area. Among them, women show a higher level of concern ($p<0.01$, Mann-Whitney). This perception coincides with the higher seriousness this group attributed to the drought. Education also affected the perception of future water availability, people with higher levels of education tended to have a more negative vision of the situation (Chi-square $p<0.05$).

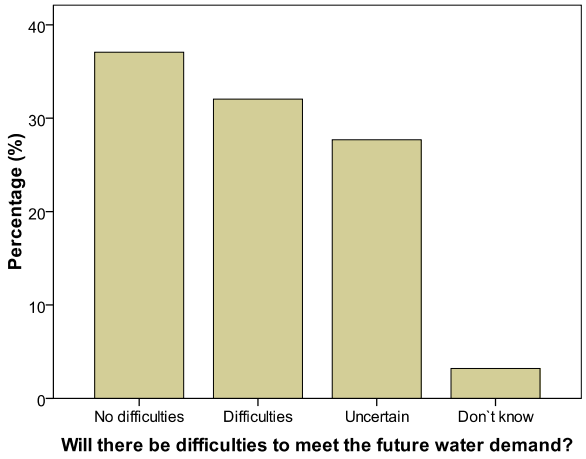


Figure 5.7: **Perception about the difficulties to meet the water needs of Catalonia in the future**

The analysis of the main reasons given by respondents regarding future difficulties to meet water demand also provides interesting insights. Most respondents (34%) attributed future difficulties to climate change and to the reduction of precipitation which is consistent with the relevance and media coverage that climate change is currently experiencing. More surprising is the consideration of population growth and high water consumption as a further major cause for the drought vulnerability of the region with 22% of the respondents referring to it. Lack of public awareness (water overuse) and inadequate water management were also pointed as potential causes of water shortages. A minor group of respondents (6%) believed that the lack of infrastructures such as transfers was the main reason behind difficulties to meet water demands (Figure 5.8).

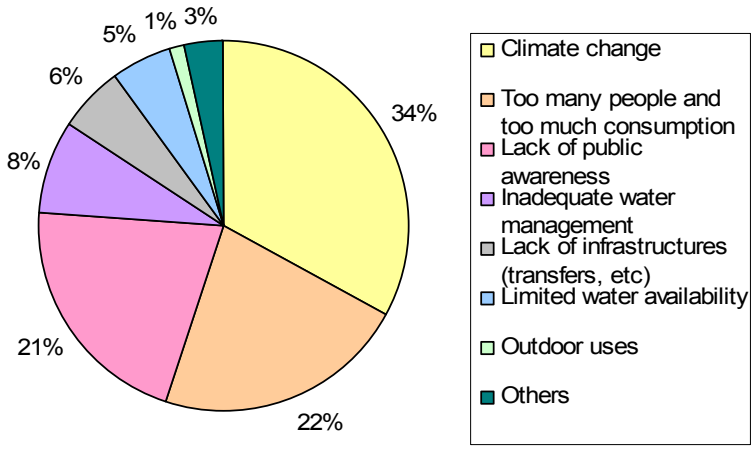


Figure 5.8: **Main reasons given to believe that in the next 10 years there will be difficulties to meet water demand**

Citizens' behavioural responses to the drought

During the most critical period of the drought, citizens were bombarded daily with figures on the level of the water reservoirs in the inner basins of Catalonia. In addition, awareness campaigns were launched by the government and public calls instigating water savings were regularly present in television, radio and the press. The response of the citizens to these messages was remarkable, as water consumption data reveals. In 2008, average water consumption per capita decreased 3.3% with regard to 2007 and reached an all-time low of 109.96 lpd (litres/person/day) in the MAB (EMA, 2008). This reduction is especially significant given that the region already was characterized by low water consumption.

A majority of residents (65.8%) adopted some measures to reduce water consumption during the drought. The seriousness that citizens attributed to the drought is consistent with their response during the episode. The residents that had adopted some measure considered that the seriousness of the drought was high ($p<0.01$, Mann-Whitney). The number of measures adopted by every household was also rather diverse since around 67% of the respondents affirmed to have adopted more than three actions to save water.

According to a study about water habits carried out in the Metropolitan Region of Barcelona before the drought (Domene *et al*, 2004), one of the uses with higher water saving potential was the shower. In 2004 only 48.1% of users affirmed to close the tap while soaping and most users 67.7% affirmed to spend more than 5 minutes in the shower which involves

consuming more than 60 litres every time they showered. The reduction of the time spent in the shower was the most adopted measure during the drought (73.8%). Other measures such as closing the tap while brushing teeth or soaping were also adopted by more than 60% of the concerned interviewees. Thus, the most followed measures were those related with everyday habits.

Structural measures such as installing diffusers in the taps or dual flushing systems in the toilet to reduce water consumption were adopted by fewer people. Still their number is also significant, as more than 30% affirmed to have installed such devices. Other measures also related with everyday habits but demanding additional efforts were also adopted by a significant percentage of residents, 22.8% of the respondents used a bucket in the shower in order to store the cold water unused until hot water came out. Some citizens (16.3%) even adopted more "painful" measures like stopping the watering of the plants (Table 5.5). The adoption of this measure was certainly more frequent among residents of single family houses. In Matadepera, 47.8% of the residents interviewed stopped watering their garden. However, it is remarkable that, at least for some time, water restrictions affected outdoor uses in the MRB and therefore, these results would reveal that not everybody followed regulations.

The percentage of households that adopted some measure was higher in single family houses (76%) than in apartment buildings (65.3%). This may be attributed to the fact that single family houses generally consume higher volumes of water because of outdoor uses and therefore, there is more scope for water savings in this type of buildings. Results from a study carried out in single family houses of Matadepera also pointed at a higher number of measures adopted in single-family households. There 84.6% of the residents had stated adopting some measure to save water in outdoor uses.

Table 5.5: Type of measures adopted by the residents of the MAB

Measure	Percentage (%) (n=263)
Reduction of the time spent in the shower or the bath	73.8
To close the tap while brushing teeth	67.3
To close the tap while soaping	65.8
Reduction of the time spent in the hand basin	60.5
To use the washing machine at full capacity	49
To use the dishwasher at full capacity	33.8
Installation of aerators in the taps	33.5
Mechanisms to control water consumption for toilet flushing	30.4
To purchase more water efficient home appliances	24.3
To store in a bucket the cold water that is wasted in the shower until hot water comes out and its reuse for toilet flushing or irrigation	22.8
To reuse water employed for washing vegetables to water the plants	18.3
To stop watering the plants	16.3
Others	12.5

Most residents (70.7%) believed that they had spent less water due to the measures adopted, 41.9% of the residents considered that the percentage of water saved was between 5 and 20 % and 12.4 % considered that it was below 5% (37.1% did not know). Most residents (91.2%)

affirmed to have maintained afterwards the measures adopted during the drought. This behaviour would partially explain the persistent reduction of water consumption achieved in the Metropolitan Area of Barcelona (MAB) since 2000. Before the 2007-08 drought, the previous drought episodes took place in the period 1999-2003 and in 2005. The reduction of water consumption is significant during the drought episodes and this reduction is maintained after the drought (figure 5.9.).

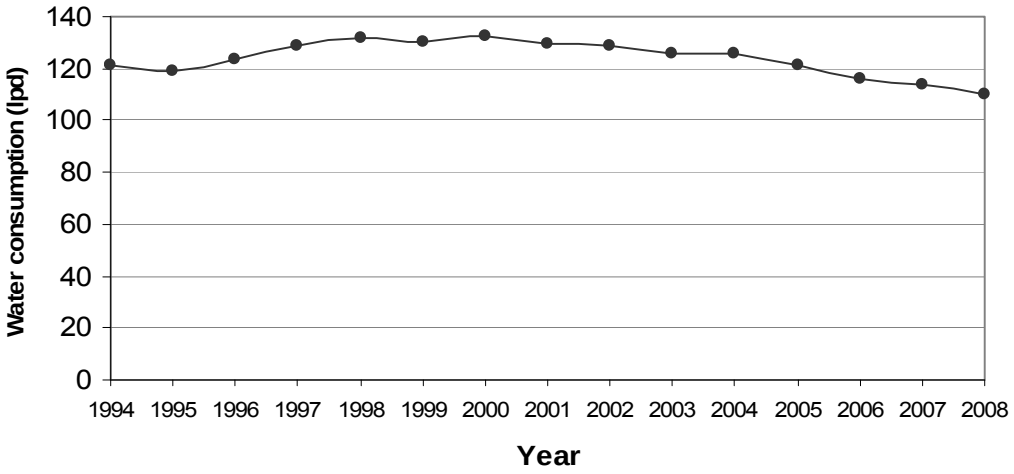


Figure 5.9: **Evolution of domestic water consumption in the MAB (1994-2008). Source: EMA, 2008**

Residents not adopting any measure (34% of the total) exposed their motivations for such decision. The main reasons were related with their water saving habits before the drought: 57% of the households affirmed that they had already adopted some measures to reduce water consumption before the drought and 47% stated that they already consumed very little water before the drought. In some municipalities of the MAB water consumptions per capita are considered very low for developed world standards, particularly in compact cities such as l'Hospitalet de Llobregat or Sant Adrià del Besos where water consumptions remains below 100 litres per day. Therefore, the scope for domestic water saving seems limited in these municipalities.

Citizens' perception of the measures promoted by the Catalan regional government

Numerous actions of different kind were adopted by the government to increase the volume of water available and to reduce water consumption. Abundant coverage of the actions taken by the government was offered in the media. Some measures such as the transportation of water by boat or the proposed water transfers from the Ebro and Segre Rivers received more attention due to their controversial character.

Table 5.6: Main measures adopted by the administration which were remembered by the respondents

Measure	Percentage (%) (n=188)	Valuation (1=very much disagree, 5=very much agree); mean value
Transportation of water by boat	23.4	2.81
Awareness campaigns	23.4	3.98
Closure of public fountains	20.7	4.54
Ebro transfer	19.7	3.47
Water reutilisation from a wastewater treatment plant for secondary uses	16.0	4.46
Rhône transfer	10.1	3.61
Recuperation of abandoned wells	8.0	4.27
Renovation of the distribution network in order to avoid leakages	7.4	4
Segre transfer	6.9	3.55
Desalination plant	4.8	4.23
Reduction of street cleaning	3.7	3.86

In spite of large publicity, more than half of the respondents (57%) did not remember any actions adopted by the administration. The measures that citizens remembered the most (23.4% of respondents in both cases) were awareness campaigns and the transportation of water by boat from other areas of Spain and Southern France. The remembrance of the latter measure could be attributed to how spectacular an action it would have seem, and the exposure it received from the media, including international mediaThe closure of public fountains and the water transfer from the Ebro River were remembered by 20.7% and 19.7% of the respondents respectively (Table 5.6). These results reveal that public fountains are one of the urban elements that become more visible during droughts.

Those respondents who remembered some measure adopted by the government were asked their opinion about the measures taken. Here, the opinion of residents that remembered the adoption of the water transportation by boat was much divided. In contrast, other measures such as the closure of public fountains, water reuse and the recuperation of abandoned wells were evaluated more positively.

All respondents were also asked about their perception of desalination. Most (69.3%) were satisfied with the idea of supplying desalinated water to the Barcelona area (Figure 5.9). Only 9.6% of the respondents were reluctant to the promotion of desalinated water which reveals a high social acceptability of desalination. On average, the measure scored 4.1 out of 5. Results from a survey conducted during the most critical months of the drought revealed a slightly lower level of desirability for desalination, as respondents gave 3.7 points out of 5 to this source when asked about their support to diverse additional water sources. These results may be attributed to the fact that citizens had not heard much about desalination yet. The desalination plant that supplies drinking water to the Barcelona area started operating in July 2009, i.e. after the drought. In the Sabadell survey, small scale measures such as rainwater harvesting or groundwater reuse were better valued than large scale measures such as desalination and water transfers which were considered less desirable (Figure 5.10).

Citizens were also surveyed about their opinion regarding the prohibition of using drinking water for outdoor uses. Most respondents (75.5%) agreed with the prohibition that applied to

outdoor uses (e.g. watering the garden and filling the swimming pool). However, these results may be also influenced by the fact that most of the respondents lived in apartment buildings not affected by these restrictions.

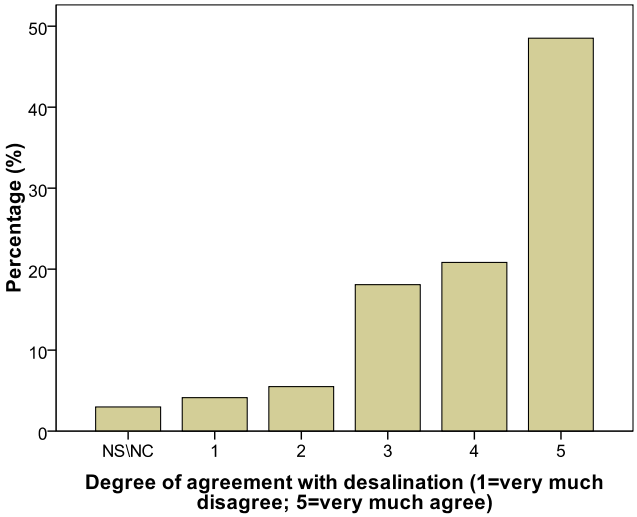


Figure 5.9: **Degree of agreement with the use of desalinated water to supply water to the Barcelona area.**

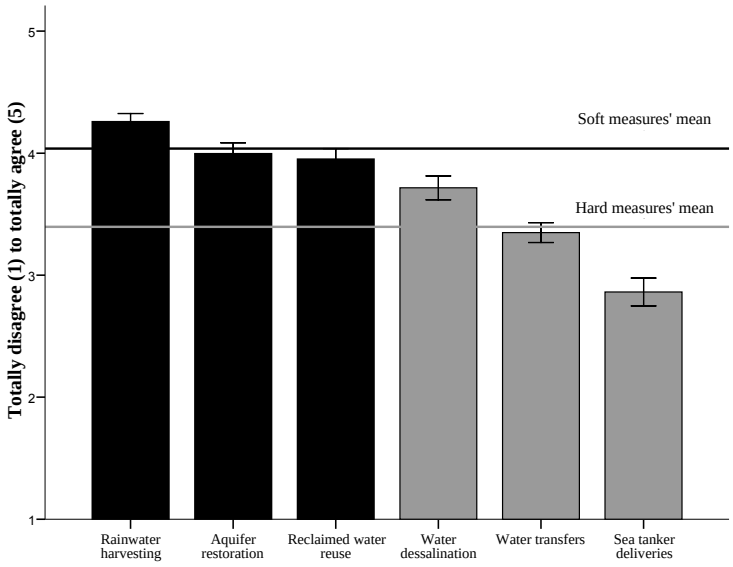


Figure 5.10: **Citizens' support to various additional water sources in May and June 2008 (Romeu, 2008).**

As for water prices, citizens considered that the price they paid for water was relatively high (average=3.61 out of 5). Only 6.8% of the respondents stated that the price was low, 30.9% considered it was neither low nor high and 56.5% considered it was high. Citizens were more willing to accept higher water prices in order to improve the quality of the rivers and the quality of tap water. Citizens were less willing to support a water price augmentation if the revenue was allocated to construct infrastructures or to reduce water consumption. These measures would increase resilience to confront drought episodes but they appear to receive less support by the citizens.

Conclusion

Drought episodes may stimulate changes in habits regarding water consumption and may also attract attention towards new management alternatives. The adoption of drought management measures at the individual or household levels may be dependent on a variety of factors, for instance gender or type of housing. The drought episode suffered by Barcelona in 2007-2008 scored high in media exposure and was considered very serious by most citizens and particularly for women. However, many people did not remember the measures adopted by the government after the drought which, in turn, may be related with the low public profile of water management under normal conditions. Hence, most people implicitly believe that droughts are transitory risks that momentarily may receive generous interest but once they are overcome, they rapidly loose social attention.

However the droughts did create changes of habit, despite the low water consumption levels registered in the MRB, significant water savings were observed during the drought and these achievements remained after the drought episodes. Thus, droughts may prove effective in changing behaviours and daily habits which can be seen as an adaptation to a ´new idea´ that water is scarcer that previously assumed, an idea invoked by the long and reoccurring drought episodes. We can't say directly that there is a perception of on an increase risk of drought from the results of this study. But we can observe an increase in awareness of taking measures to adapt to the drought by conserving water, a measure which continued long after the drought (Figure 5.9). And the conservation of water as a new habit in the community does place them in a better position to handle another drought, and perhaps even reduce it reoccurrence which does refer back to resilience and adaptation ideas.

In consideration of the resilience discourse, it seems that the major structural issues to address during droughts are left in the hands of institutions. Citizens are willing to engage in private water consumption reduction and also support governmental measures, as long as the changes are not too drastic, and they seem content in that role. Perhaps part of the answer is in relation to the focus of this survey which is not directed to elucidate more communitarian moves towards resilience. Nevertheless we need to consider the division of citizens' perceptions of their responsibility vs. the governments, which can be seen within the answers to the survey.

5.3 Alpine hazards

Anna Scolobig, Bruna De Marchi, Luigi Pellizzoni, Chiara Bianchizza

The case study area[4]

The Adige Sarca river basin, in the Eastern Italian Alps, is located in a high mountainous landscape where the main natural risks are represented by debris flows, landslides and flash floods. The following study deals with some of these events which occurred in the fall season of the year 2000 and/or 2002. More precisely, the focus will be on four communities in the Trentino Alto Adige Region: Bocenago (372 inhab.[5], 750m a.s.l.), Romagnano (1,272 inhab., 204 m a.s.l.), Roverè della Luna (1,472 inhab., 251 m a.s.l.), and Vermiglio (1,856 inhab., 1,261 m a.s.l.). All have been affected by similar events which caused damages and the partial or total evacuation of the population. More precisely, in November 2002 a debris flow slid down into the centre of Bocenago and struck several houses, forcing the evacuation of about 150 people for a week. In Romagnano a similar event caused even more severe consequences: a debris flow travelled 200 m before hitting and damaging a number of buildings, to finally deposit in the central square. Almost 500 people were evacuated. During the same time in November 2000, a huge, but slower-evolving landslide affected Roverè della Luna**,** where the decision to evacuate the entire village was taken mainly as a preventive measure. The last site, Vermiglio, was hit by two debris flows, at a two year time interval (November 2000 and November 2002). The first time three bridges were destroyed and about 100 people were evacuated for a few days. Two years later, a new debris flow caused damage in the same area.

In these communities a risk perception study has been conducted within the frame of the Integrated project FLOODsite. The aim of this study was to better understand not only risk perception, but also individual and community vulnerability and resilience, by providing a faithful account of the hazard in these locations, as experienced and described by different social actors (De Marchi et al. 2007). The approach to studying risk perception did not start from a coherent and consistent model of how individuals perceive and evaluate risks. A nested approach was used instead, starting from the assumption that cognitive and affective factors interact with social, economic, cultural and contextual ones in defining the way people "live with" risks (Renn 2008; Renn and Rohrmann 2000). Risk perception was not considered as something objectively given, but subjective, dynamic and socially constructed (Douglas and Wildawsky 1983; Beck 1992; Strydrom 2002; Jasanoff 1998; De Marchi *et al.* 2003). This means for example that people frame risk in different ways which may change over time and that their judgments about

[4] The work described in this section is based upon the contribution to FLOODsite – "Integrated Flood Risk Analysis and Management Methodologies" – an interdisciplinary project integrating expertise from physical, environmental and social sciences, as well as spatial planning and management. The project ran from 2004 to 2009 and had over thirty research tasks. This chapter derives from research accomplished in task 11, "Risk perception, community behaviour and social resilience" by Bruna De Marchi, Anna Scolobig, Giovanni Delli Zotti and Maura Del Zotto at ISIG Gorizia. Within this task, parallel research was performed in Germany by Annett Steinführer and Christian Kuhlicke at UFZ Leipzig, and in the UK by Sue Tapsell, Sylvia Tunstall, Colin Green, Edmund Penning Rowsell and Amalia Fernandez-Bilbao at FHRC Enfield.

The project was funded by the European Community's Sixth Framework Programme (contract GOCE-CT-2004-505420¸ http://www.floodsite.net).

[5] The number of inhabitants derives from the last Census data (ISTAT, 2001).

risk are influenced by norms and values, belief systems, place attachment, local and expert knowledge, etc. (Tharaldsen and Haukelid 2007).

In the following empirical example we will focus on people's judgments, attitudes and opinions about typical hydrological phenomena of this Alpine region represented by the combination of flooding and debris flows. How do people evaluate this danger? Do they have different conceptual framings about it? Why? We will deal with these issues in the following sections, after a brief description of the research design.

Research design

The research design foresaw the triangulation of different methods and techniques for collecting information including both data amenable to statistical treatment and narratives subject to hermeneutical interpretation. More specifically, data were collected from: secondary sources (Census, historical archives, newspapers, etc.), participant observation in the four communities, semi-structured interviews (15) and focus groups (2) with "key informants"[6], surveys with a largely pre-structured questionnaire.

Here we focus on the results of the surveys, which were conducted face-to-face with a total of 400 local residents, 100 for each selected site. In each village, our sample was drawn so that it included quotas of people selected according to the distribution of gender, age, education, and level of risk exposure (high, medium, low)[7] in the overall population. The questionnaire[8] included numerous questions aimed at understanding risk perception. Respondents were asked to evaluate the feeling of danger induced by hydrological phenomena and their personal knowledge of the hazard. We also explored their opinions about the possibility of future events, their awareness of building developments in risky areas, their judgements concerning building restrictions in these same areas, their attitudes towards structural devices and their feeling of safety induced by various elements (e.g. civil protection services, voluntary organisations, protection works, warning systems, etc.). For many of these questions we asked respondents to explain their answers (in an open-ended form) to gain a more complete picture of their conceptual framing of risk. In the following sections, we will focus on only some of these results.

For the data analysis we used a set of more than 20 independent variables divided into four sub-sets: location-event related (e.g. risk exposure, flood impact, length of evacuation, etc.); socio-demographic (e.g. age, gender, educational level, occupation, etc.); community structure (e.g. trust in local authorities, support or advice networks, etc.), personal history (e.g. flood experience, level of preparedness, risk awareness, etc.). We crossed them with the variables used to operationalise risk perception to test whether there were any statistically meaningful relationships (for a complete description of the research design see De Marchi et al. 2007).

[6] So called "key informants" are people who, due to their status, role or experience, have a deep knowledge of the subject under investigation and/or the relevant social context. They included local authorities, civil servants, community leaders, politicians, scientific and technical experts, members of non governmental organizations (NGOs), etc.

[7] Data about risk exposure were based on the risk maps (when available) or the indications provided by the municipal technical officers.

[8] The questionnaire was constructed in strict collaboration with the other partners involved in Task 11 of the FLOODsite project (see Steinführer and Kuhlicke 2007, Tunstall *et al.* 2007). We designed it on the basis of a literature review and of the results of the previous phases of the research (i.e. semi-structured interviews etc.).

Feeling endangered

Several research results reveal that hydrological phenomena do not represent a great worry for the residents.

First of all, the picture gained about the awareness of past and future events is quite discouraging. The percentage of respondents found to be aware of risk before the events is not very high (43.8 %), considering that all four communities had been struck by floods or debris flows in the past. Even after the events, only less than half of respondents (48%) think that something similar might happen again, mostly due to the structural-morphological characteristics of the territory (36.6%). A certain fatalism is also revealed by the high percentage of those mentioning the unpredictability and uncontrollability of the events (19.6%), as the main motivation for their responses. Other reasons are related to similar events happened in the past (16%) or the inadequate territory management (13.9%), etc.

These results are in line with answers to the question “Do you think hydrological phenomena represent a danger/threat to your physical integrity?” which produced a very low mean value of 1.7, on a five point Likert scale[9]. We obtained higher mean values when we posed the same question with regard to one’s own home (1.95) and especially the entire village (2.65). These data seem to reveal the existence of a *hiatus* between the evaluations of personal and collective risk, with an inclination to underestimate the former. Some insights for the interpretation of these data may be provided by the cross-tabulation of these variables with the independent ones. In Table 5.7 we report only statistically meaningful relationships.

The residents who live in higher risk areas give also higher evaluations about the danger for their homes and physical integrity, than those living in low or medium risk areas. The same is not true with regard to the evaluations of danger for the village. To understand these results we have to consider that in these mountain villages risk is not “fairly” distributed: the riskiest areas are usually those along the rivers and torrents, which were also the most severely damaged during the events in the year 2000 and/or 2002. It is exactly in these areas that residents are more conscious of risks possibly because they have been affected recently by an event and/or they have to “live with” the danger sources in their everyday life, etc. (see section 4). These results give some hints to understand the hiatus between the evaluations at personal and collective level mentioned before. Indeed we have to consider that the residents living in the highest risk areas represent only a (relatively small) percentage of our sample (24%), which, at the same time, reflects the actual distribution of risk exposure in the communities under study (as one of the sampling criteria was risk exposure, see Research design).

If we now look into the evaluations of collective risk, variations among the four villages are also relevant (Table 5.7). A mix of contextual factors and local flood/debris flow history-experience seems to be important in influencing these evaluations. For example the highest concern for the village being threatened emerges in Vermiglio (3.15 vs. 2.20 in Roverè) which is the only community hit by two consecutive events in a few years: the second event destroyed the structural devices constructed after the first one, causing scepticism among the local residents about the possibility of “controlling nature”.

[9] In the items that we constructed as Likert scales, respondents used scores from 1 to 5, with 1 as the minimum value and 5 as the maximum one.

Our data reveal also that it is not only the experience "in itself", but especially the severity of the personal consequences related to past events which makes the difference in driving respondents' evaluations. The lower the flood/debris flow impact[10] suffered by the residents, the lower their feeling of being in danger related to hydrological phenomena (for their physical integrity, home and village). This result is also supported by other research (Green et al. 1991; Mileti and O'Brien 1992; Deeming 2008) which reveal that a flood experience without severe consequences may have the paradoxical effect of decreasing residents' risk awareness. Mileti and O'Brien (1992) describe the residents' reasoning in the following way: "If in the past the event did not hit me negatively, I will escape also negative consequences of future events" (1992, 53).

In the literature review of the previous sections (3 and 4) of this report, not only the flood experience but also the level of trust in the local authorities in charge of risk management was presented as a key factor influencing risk perception. This is confirmed by our results: more precisely, the lower the respondents' feeling of danger related to hydrological phenomena the higher their level of trust in local authorities[11] (see Tab. 5.7). We hypothesize that one of the reasons behind this result might be a process of delegation of responsibility for safety to the agencies in charge of risk mitigation, which has the paradoxical effect of decreasing peoples' risk awareness. Some residents for example may not feel endangered because they think that the risk (and its management) is a task of the local services. Others may think that the services are already efficient enough.

Finally, it is worth mentioning that the cross-tabulation revealed that there is no significant relation between "feeling endangered" and "feeling prepared" or "adopting preparatory measures to protect the household". This challenges the assumption that the concern about the risk translates automatically into the adoption of self-protection behaviours or better individual preparedness as reported in several policy documents, e.g. "Preparedness is a result of risk awareness and is based on the necessary information to make the individual recognize his/her possibilities of action" (Water Directors of the European Union 2002: 6). This confirms that an attitude, i.e. risk awareness does not automatically translate into a behaviour, i.e. adoption of preparatory measures, as already revealed by several studies in other fields not necessarily related to risk (Eagly and Chaiken 1993; Cialdini 2001).

Table 5.7: Results of the cross-tabulation

Hydrological phenomena are a danger for the village

	Mean	N
Entire sample	2.65	388

[10] This index was constructed using six variables measuring respondents' evaluations about the flood impact, i.e. the severity of personal physical damage, psychological problems, stress and tension within the village and the family, damage to working place, damage to house(s), furniture and content.

[11] This index was constructed using three variables measuring the level of trust in civil protection, voluntary organisations, and municipal authorities

Research location	Mean	N	Level of trust	Mean	N
Bocenago	2.77	98	Low	2.99	102
Romagnano	2.45	98	Medium	2.65	159
Roveré	2.20	93	High	2.37	127
Vermiglio	3.15	99	**Sig.** .000	**Eta** .202	**Eta²** .041
Sig. .000	**Eta** .302	**Eta²** .091			

Flood impact	Mean	N
No	2.47	143
Low	2.63	108
Medium	2.56	80
High	3.26	57
Sig. .000	**Eta** .224	**Eta²** .050

Hydrological phenomena are a danger for one's home

	Mean	N
Entire sample	1.95	393

Risk exposure	Mean	N	Level of trust	Mean	N
Low	1.69	201	Low	2.24	105
Medium	2.04	99	Medium	1.82	159
High	2.42	93	High	1.88	129
Sig. .000	**Eta** .269	**Eta²** .072	**Sig.** .007	**Eta** .158	**Eta²** .025

Flood impact	Mean	N
No	1.74	148
Low	1.87	108
Medium	2.11	81
High	2.45	56
Sig. .000	**Eta** .220	**Eta²** .049

Hydrological phenomena are a danger for one's physical integrity

	Mean	N
Entire sample	1.70	395

Risk exposure	Mean	N	Level of trust	Mean	N
Low	1.52	201	Low	1.97	105
Medium	1.70	101	Medium	1.63	161
High	2.11	93	High	1.57	129
Sig. .000	**Eta** .231	**Eta²** .053	**Sig.** .007	**Eta** .159	**Eta²** .025

Flood impact	Mean	N
No	1.53	149
Low	1.56	110
Medium	1.80	80
High	2.30	56
Sig. .000	**Eta** .257	**Eta²** .066

Framing the danger

To better understand how respondents frame the danger, we asked them to explain their evaluations about the risk at collective level. They provided many different justifications (Figure 5.11) that we can group as follows: unpredictability and exceptionality of the events (33.8%), presence of protection works (27.5%), personal knowledge of the territory (19.8%), and quality of land use planning and management (12%).

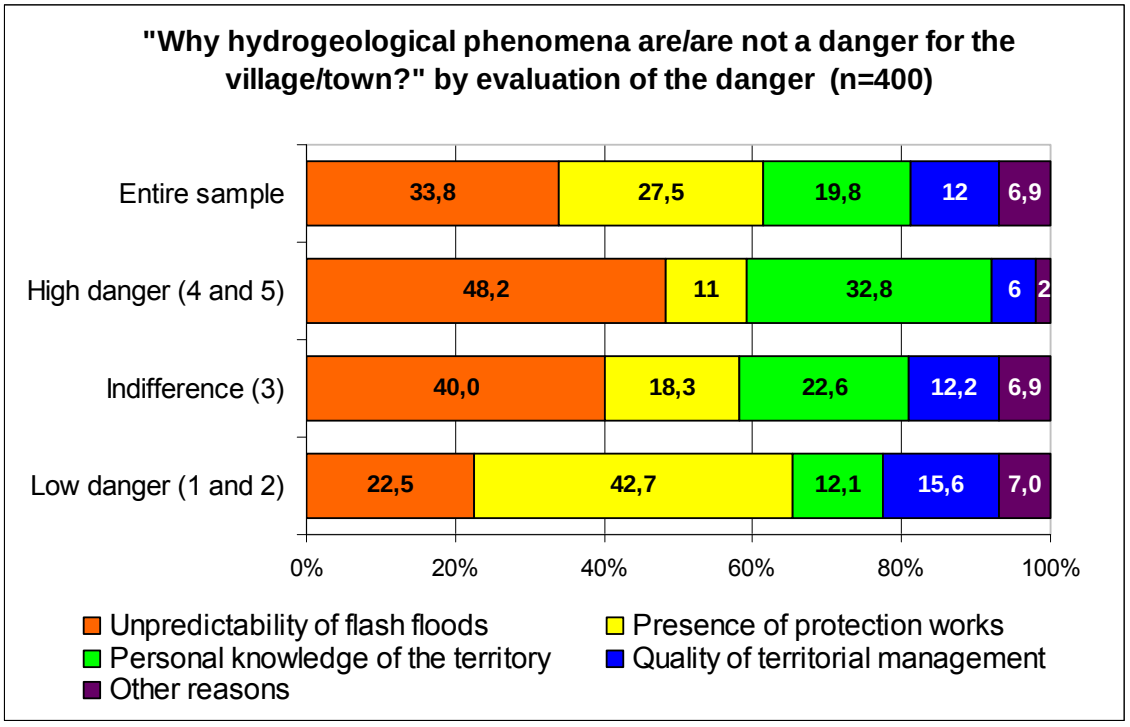


Figure 5.11: **Motivations for feeling in danger**

Those less worried about the danger (score 1 or 2 for danger evaluation: 43.5% of the sample) are more likely to rely on technical intervention as a guarantee of safety. In fact, most of these respondents (42%) mention the presence of structural devices as tangible signs of protection, as shown by answers such as: “Thanks to protection works we are safer”; “I know our streams are dangerous, but I trust structural devices”. Carolan (2007) offers an interesting interpretation of the reassuring role played by these devices. He mentions an institutionalised trust bestowed upon these structures with each passing flood-free year. “Individuals come to have a growing confidence in them and think: ‘They’ve protected us in the past; why would they fail now?’”(*ibid.*:

46). The relation between the protection capacity of structural measures and the induced collateral effect of lower risk awareness among the local people has been recognised by several authors (Dynes, 1974; Burby and French, 1981; Bye and Horner, 1998; Enserink, 2004; Morris and Sinclair 2005; Colten and De Marchi 2009).

Going now back to the justifications produced in relation to the evaluations about danger, it is interesting to note that the main reasons adduced by the least worried respondents are totally different from those cited by the most worried ones (the 25% of the sample with a score of 4 or 5). The latter mention the unpredictability and exceptional nature of the events (48.2%) or knowledge of the features of the local environment (32.8%) as the main motives for feeling endangered. For example, they claim that: “In these mountain areas, flash floods/debris flow may always happen”; “We perfectly know where the streams may break out of their banks”. Some respondents even mention some toponyms in local dialects, which embody the memory of past events: for example, *Prà dell’Acqua* (water meadow), *March* (rotten soil) and *Slavini* (flash floods).

As shown by these examples, local knowledge plays a relevant role, especially considering the peculiar characteristics of these events, their localized nature, short lead times and related difficulties in official warning. Indeed most of the times, especially in high mountain and isolated communities (as Vermiglio and Bocenago in our case), inhabitants know that they can rely only on their knowledge and the “community resources” during an event. Nevertheless, the relevance of local knowledge should not be exaggerated. In fact, as reported by many interviewed fire-officers and civil protection officers, traditional keepers of the knowledge of the territory are hardly present anymore, due to depopulation of these mountain areas in the past decades. Also the networks and the links within the community that in the last decades granted the transmission of this knowledge from generation to generation have weakened; in some cases they are blocked, in others they do not work anymore.

Risk and safety

Discourses about risk and safety are complementary: for example by investing in risk mitigation measures, community safety is increased. However, do residents consider “feeling endangered” as the opposite of “feeling safe”? Or, in other words, are risk and safety considered as two faces of the same coin?

Our results suggest this is not the case. While the risk and its perception are related to all the aspects mentioned so far, safety derives from a plurality of factors, including the presence of a local fire brigade corps, the efficiency of the civil protection, the (assumed) safe location of one’s house and/or place of work and the existence of a warning system. Respondents were asked to evaluate on a Likert scale a set of factors which might contribute to their personal safety. Considering the mean values in descending order, the hierarchy obtained is the following: voluntary fire brigades (4.53), provincial civil protection services (4.41), existing protection works (4.14), the home one lives in (4.02), warning systems (3.89), personal experience (3.26), fellow villagers (2.94), information received (2.73).

By performing a principal component analysis (Figure 5.12), we found that the “safety catalysts” can be grouped in two sub-sets: *formal*, i.e. civil protection services, voluntary organisations, protection works and warning systems, and *informal*, i.e. personal experience,

fellow villagers, information available. The former ones definitely contribute more to a feeling of safety.

As a result, risk and safety mental frames seem to be completely different, as supported also by other research findings. This has several implications for the design of risk communication strategies, as we will see in the following section.

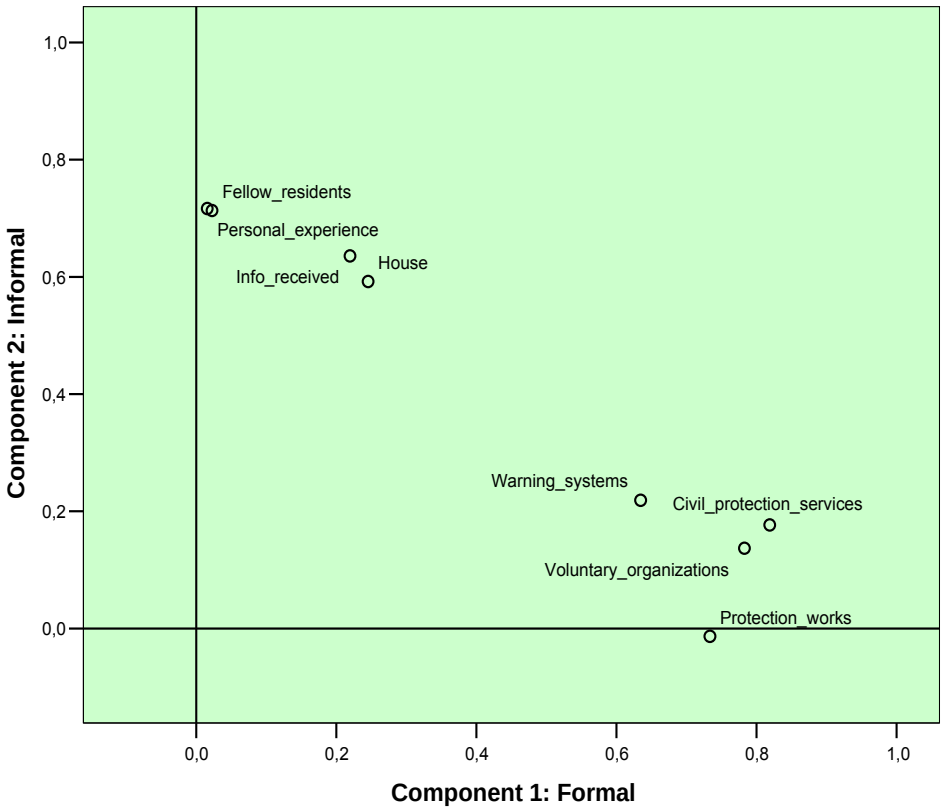


Figure 5.12: Formal and informal safety catalysts

Conclusion

Local residents are not very concerned about hydrological phenomena and do not take into serious consideration the possibility of being personally at risk. There is also a clear *hiatus* between the evaluation of personal and collective risk, with an inclination to underestimate the former. The reasons behind this *hiatus* seem to go far beyond individual risk denial or level of risk exposure and need to be better understood.

Not only the risk exposure, but also the seriousness of the personal consequences of past events and the level of trust in local authorities shape the respondents' evaluations about the danger. It seems that those least concerned tend to delegate more easily the responsibility for safety to the agencies in charge, thus increasing both individual and institutional vulnerability. As a result, there may be a peril that the agencies' good performance encourages the residents' progressive disengagement with risk and culture of self protection, which arguably holds true for many countries where the public has high expectations and relies on the experts to "do something" in response to natural hazards.

Our results show also that feeling more or less endangered is also linked to the conceptual framing of the hazard. The least concerned concentrate mainly on the presence of structural devices, whereas the most concerned focus on the unpredictability and exceptionality of the events, also based on personal knowledge of the territory and the danger sources.

Several results reveal the importance of contextual factors in influencing opinions and attitudes toward risk. Not only local knowledge of danger sources, but also history of past events, institutional arrangements, and the community of belonging do matter.

Finally, two other results need further enquiry, i.e. the relationships between i) risk awareness and preparedness; ii) risk and safety. On the one hand, there is a need to better understand the link between risk evaluations and cautionary actions aimed at self-protection. As social scientists know far too well, the relationship between attitudes and behaviours is never a simple one, but it may be also strengthened under certain conditions, as revealed by studies in other fields not necessarily related to risk (Eagly and Chaiken 1993; Cialdini 2001).

On the other hand, the practical implications in terms of communication of the different conceptual framings about risk and safety need to be explored. As widely acknowledged (see for example CapHaz-Net WP 5 Report on Risk Communication), communication should be considered as a two way process, which starts from listening to people to understand their knowledge and value references, taking into account their framings to provide them with relevant information in a comprehensible form. If we embrace this assumption and apply it to our results, risk communication should aim at re-discovering local knowledge, unveiling the uncertainty related to these events, pointing out the ambiguous role played by structural devices. Safety communication instead should aim at building or strengthening formal and informal networks and reinforcing adaptive capacity, especially at a community level. This means engaging in a continuous and dynamic process of establishing durable relationships among residents, interest groups, organisations, and institutions involved in risk mitigation and management (Steinführer *et al.* 2009). Nevertheless, with regard to these issues there is still a critical gap to bridge between “how people judge risk and safety”, “what they need to know to take decisions about these issues in their everyday life”, and finally “what are the main aspects to take into account to design effective two-way, continuous and dynamic communication processes”.

6 Practical approaches of risk perception research in the context of social capacity building

Given that governance (WP2) and social capacity building (WP1) infer the use of networks and communities in active participation, we also need to ask how risk perception influences or is changed through participation. There has been work suggesting that participation in discussions and movements that actively talk about the risk/hazard concerned can change the perception of the entities involved. “Cognitive heuristics and biases that shape individual risk perceptions, amply demonstrated in cognitive psychology, are in themselves shaped by organisational and institutional contexts” (Jaeger et al., 2001:168). Much of this work however comes from the literature on technological risk (Cronin, 2008; Hamstra, 2000, Renn, 2008). The public debate about the environmental risks related to an Italian high-speed train showed once more “that early dialog among all the parties involved was critical in forming a personal viewpoint on risk, which, once consolidated, defied new information and perspectives” (Marincioni and Appiotti, 2009: 863).

The perception of natural hazards is in some important respects different from the perception of technological and chemical risks (see section 2.1). Yet, as we saw earlier, the distinction between natural and technological hazards is not always straightforward. This distinction is further clouded as it becomes increasingly possible to mitigate, at least to some extent, the impacts of natural hazards. Floods for example are something that are commonly controlled and mitigated to some degree. This changes the common perception of risk as fate model for natural hazards, Therefore it is necessary to consider how these changing perceptions affect participation.

For water resource management it has been shown by a number of studies that social learning processes were induced by multiparty collaboration networks (Pahl-Wostl et al., 2007; Stanghellini and Collentine, 2008). Paton (2008) in his study of risk communication and natural hazards argued that risk communication needs to be based on community engagement. He found that participation made a significant contribution to the overall decision making process. A finding that is consistent with suggestions that peoples’ concept of environmental risk is influenced by others’ views, as are the choices they make regarding its mitigation (Lion, Meertens and Bot, 2002; McGee and Russell, 2003; Earle, 2004; Poortinga and Pidgeon, 2004, Paton 2008:12). Miceli showed that flood preparedness was positively related with flood perception (Miceli, 2008). The Joint Defra/Environment Agency R&D programme (UK) “Managing the social aspects of flooding” found that it is “encouraging that a community that has been involved in a genuine participatory exercise (either through facilitated historic and/or scientific projects) or a community that has been involved in management decision making will have already begun to ‘own’ its flood risk environment and will have developed a sense of trust towards the facilitators …” (Twigger-Ross 2006) They recommend future research on community risk perception.

Brody et al. investigated the learning by decision makers during a period of seven years with regular flooding events in Florida and reported that “local jurisdictions do in fact learn from histories of flood risks. And from a case study of muddy flooding risk in France Heitz et al. claimed “that obtaining information on risk perception contributes to the understanding of the main social factors that should be taken into account in an efficient muddy flooding risk management policy” (Heitz et al., 2009: 443). Trust was regarded as the key factor in the muddy

case study as well as in flood management (Paton, 2008). In the Netherlands the interaction between scientific and local experts (see section 3.1.) changed risk perception the style of communicating the different views on flood risks during flood management workshops (Slinger et al., 2007). There is substantial evidence to suggest that risk perception will affect participation in hazard mitigation processes but also that through the process of participation risk perception is changed.

Incorporating risk perception information into the risk governance of natural hazards

Current literature on risk perception has asked for the participation of the public as a necessary precursor to the implementation of protection policies. “The most important policy question is how to treat risk perceptions in a policy arena that includes responses of different actors and the general public” (Renn, 2009). Risk appraisal should include not only the scientific assessment of the risks to human life and the environment but also the concerns of the different stakeholder groups, including the public, the policy makers and the experts. These concerns can be investigated by different methods provided by the social sciences; as mental models (Kolkman et al, 2005, Kolkman et al., 2007) focus groups or stakeholder hearings (Renn, 2009). Meyer et al. showed recently (2009) a multicriteria risk mapping approach which could provide a method for dealing with uncertainties in flood risk assessment and to include social and environmental flood risks.

This participatory approach may offer a solution to some of the difficulties that have been discussed earlier. “Public participation offers a workable setting for a solution of many – but certainly not all – controversies concerning environmental and technological risks“ (Jaeger et al., 2001: 286). An example from flood hazard research suggests that participation could lead to the reconciliation of practically-oriented and experience-based local knowledge accumulated in flood-prone areas with the general expert knowledge of flood issues (Krasovskaia, 2001: 856). This could address one of the biggest obstacles to governance, the mismatch between different knowledge and different interests of different stakeholder groups, including experts (see section 3.1). Participation may lead to a greater familiarity with the risk which can bring benefits. Through participation and discussion of the risks, an event becomes more easily recalled and therefore more likely to be dealt with (Rowe & Wright, 2001 cited in Botterill and Mazur., 2004, Llasat-Botija, Llasat & López 2007).

Participatory approaches are not straightforward however and they have limitations as well as benefits. One result of the participation process, if it is to be genuine participation, is that the responsibility for risk protection is - at least in part - transferred from government to the participants. If the participants have no responsibility or authority then they are not genuine participants in the process. There is also evidence that superficial forms of participation, where those being consulted have no ability to influence decisions, but are asked simply to endorse decisions already made, can negatively impact on the relationship between the ‘experts and the ‘lay people’. This transfer of responsibility has a number of implications and may produce unintended outcomes (Petts and Leach, 2000).

Participation is often carried out through stakeholders, who represent certain groups or interests. The choice and classification of these stakeholders can then play a fundamental part in the participation process (Stanghellini and Collentine, 2008). If the participating stakeholders have different power in the process, particular stakeholders could come to dominate the

decision. Sjöberg (2001) criticises participatory approaches, asking what part of the public a stakeholder in these participatory discussions represents? Stakeholders, by their very nature, have vested interests, willingly devoting their time to educate themselves and participate, they are therefore in at least some respects atypical for representing overall public concerns and preferences.. His suggestion (for Sweden) is to use national referendums to allow participation in governance; this may hold some weight as the two Swedish cases provided on nuclear sitings had a voter turnout of 76% and 87% (Sjöberg, 2001). It would not be practical, however, for more frequent and ongoing forms of participation, such as those being attempted by the Environment Agency in England in relation to flooding.

In natural hazard assessment, participation is not as common yet as for example in water management processes (see above). However, a deliberative participant-led multi criteria approach has been developed by Kenyon (2007) for a flood risk management in Scotland. As mentioned above, in England there is an attempt to move towards a more participatory approach and considerable research has been carried out by the Environment Agency and the Department for Environment Food and Rural Affairs to assist this process. They distinguish between 'stakeholder engagement' and 'community engagement'. Stakeholder engagement' "necessarily focuses on dialogue with *representatives* of the stakeholder groups" whereas 'community or citizen engagement' involves the wider public (Cornell 2006: 8). It is also recognised that there are "degrees of participation in decision making" (Petts and Leach 2000: 2).

Communication of uncertainty (see section 3.6) requires a participatory approach where scientists no longer have a uniquely privileged position. "Once outside the laboratory scientists are citizens among others, contributing their special knowledge, which is different but not dominant, among the other sorts of knowledge in the policy dialogue". Knowledge of how risks are perceived and how people act when confronted with a natural hazard such as a flood, is at least as important (and not as uncertain) as the knowledge of how often a flood takes place in a particular location. It is an astonishing fact for example, that natural hazards (for which scientific prognoses have a high degree of uncertainty compared to other natural events), "are perceived as regularly occurring and thus predictable or related to a special pattern of occurrence (causal, temporal or magic)" (Jaeger et al., 2001: 105).

Such observations should be included in risk management plans and must lead to new forms of public participation in risk governance. For example Pahl et al. (2007: 6) noted in their study about social learning in water resources management, that water management is facing increasing uncertainties because of climate change, fast-changing socio-economic conditions and the goal of integration over a wide range of objectives". This implies that people "have to learn to live with change and uncertainty" and therefore new governance approaches have to be developed, which combine stability with a collaborative approach of adaptation. One approach is the "reflected discourse" (Renn 2008: 277), which addresses the question "how much uncertainty and ignorance are the main actors willing to accept in exchange for some given benefit" and this is considered further in section 5.

Risk governance of ambiguous risks (section 3.7) implies decisions on which risks a society is willing to tolerate has to be made by all stakeholders, including the general public. Therefore for ambiguous risks a special form of risk governance which includes a participatory discourse is needed. A risk management escalator shows the required stakeholder involvement from linear to complex and uncertain to ambiguous phenomena (figure 6.1, from Renn, 2008:

280, figure 8.1). Floods are usually perceived as “natural hazards” and therefore rate relatively low on the perceived risks scale compared with technological hazards (Plapp and Werner., 2006: 107; Slovic, 1996: 171-172; McDaniels, et al., 1995: 587, see section 2). A limited participation effort that includes the directly affected stakeholders would probably be sufficient to absorb potential discontent and to sustain trust. However, this picture is gradually changing, As shown in section 4 flood risks tend to be regarded as being more and more induced by humans rather than by God or nature. (Sjöberg, 2000, Baan et al., 2004). They fall out of the category “natural” occurrences and are associated with (inappropriate or faulty) human actions. This shift in accountability places more stress on those institutions that regulate and administer flood protection. According to Renn, 2008 (Figure 6.1) these “human made” floods would necessitate a more elaborate discourse system, in which representatives of “civil society” need to be represented.

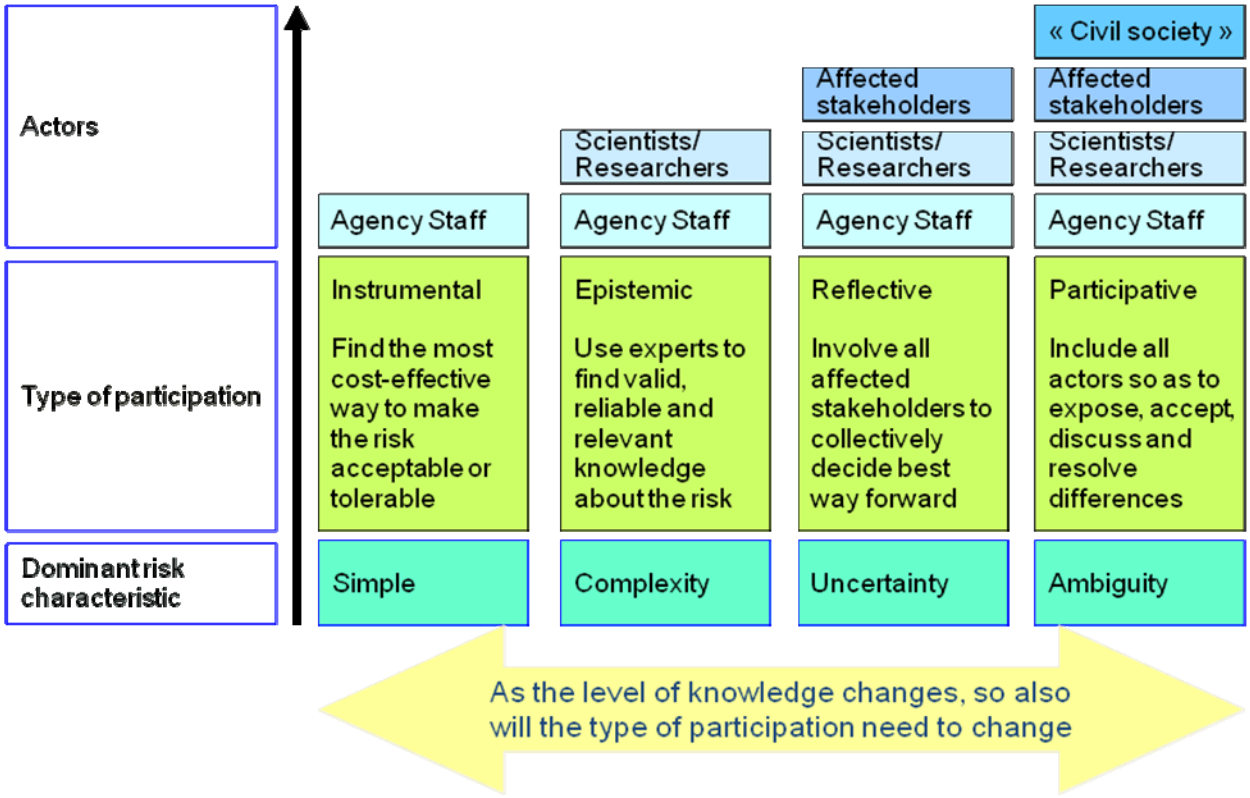


Figure 6.1: The risk management escalator (source: adapted from Renn, 2008)

There is considerable pressure for an increase in public participation in decision-making, much of it arising from sustainable development policies. “Agenda 21 of the 1992 Rio Conference on Environment and Development recommends that the broadest possible participation should be encouraged and in several places advocates a ‘community-driven’ approach. Principle 11 of the Rio Declaration on Environment and Development states that “environmental issues are best handled with the participation of all concerned citizens, at the relevant level. … each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in the decision-making process …” (Petts and Leach 2000: 5) . The

relationship between participation and risk perception will therefore be of continuing importance and will need further research.

Part III: Conclusion

The main purpose of this paper has been to explore how people perceive risks, in particular those associated with natural hazards and to investigate how perceptions influence the vulnerability of hazard-absorbing systems such as human settlements or cultivated areas. In addition, the paper introduced some suggestions regarding risk communication and public involvement methods for influencing people's perceptions and behaviour in order to improve resilience.

The paper started with a general review of the risk perception literature over the last 30 years. The starting point of the analysis was the insight that the social experience of risk is not confined to the technical definition of risk, i.e., the product of probability and magnitude (Rappaport, 1988: 191). What human beings perceive as threat to their well-being and how they evaluate probabilities and magnitudes of unwanted consequences is less a question of predicted physical outcomes than of values, attitudes, social influences, and cultural identity (Douglas and Wildavsky, 1982: 38; Breakwell 2007).

Although three decades of research have created a substantial base of understanding regarding how people perceive and respond to risk, a comprehensive concept of the social experience of risk, i.e., the social processing of uncertainty and the perception and evaluation of expected consequences related to an event or activity, is still missing (Horlick-Jones and Sime 2004). The risk field is a patchwork of many different schools and perspectives.

Psychological risk perception research has revealed that contextual factors shape individual risk estimations and evaluations (Covello, 1983; Slovic, 1987; Breakwell, 2007; Renn, 2008: 98ff.). The identification of these factors, such as voluntariness, personal ability to influence risks, familiarity with the hazard, and the catastrophic potential provides useful information about the elements that individuals process for constructing their interpretation of risks. In addition, analyses of people's heuristics in making inferences have shed some light on how risk information is generalized and evaluated intuitively (Tversky and Kahneman, 1975; Kahneman & Tversky, 1979; Gigerenzer, 2007). These psychological studies fail to explain, however, why individuals select certain characteristics of risks and ignore others. Furthermore, focusing only on the individual as an information processor, these studies exclude from the analysis the social and cultural variance of risk interpretations.

Sociological analysis provides some further insights into the social and organisational factors that influence risk experiences (Jaeger et al., 2001: 144ff). Some studies focus on the organizational capability of risk management institutions to cope with large-scale risks and to function vis-à-vis competing demands from various social groups (Perrow, 1984; Short, 1984; Clarke, 1989; Hutter, 2006). Others attempt to identify social influences in the formation and change of attitudes towards risk-bearing activities or technologies (Taylor-Gooby, 2006)). Some aspects, such as perceived fairness in the distribution of risks and benefits, have gained special attention as part of the dynamic interaction among the various groups involved in rejecting or legitimising a proposed imposition of a risk on a special population (Kasperson and Kasperson, 1983; Linnerooth-Bayer & Fitzgerald, 1996; Lidskog, 2005). More theoretically oriented studies have emphasised the social construction of risk interpretations and their affinity to different types

of knowledge acquisition, social interests, and cultural values (Bradbury, 1989; Jasanoff 1984; 1998; Zinn & Taylor-Gooby, 2006). These studies culminate in the concept of reflexive modernization in which risks have become dominant features of peoples' experiences about the increasing loss of security and firm expectations of what to expect in the future (Beck, 1992; 1994; 1999; Giddens, 1994). These sociological studies have been valuable and helpful for understanding the variability of risk interpretations among different groups and for pointing out the organisational problems that aggravate the potential outcomes of risks due to institutional constraints that impede effective risk management and control. However, they remain scattered and often fragmented and fail to link scientific risk assessments, individual perceptions, and the social and cultural experience of risk.

Coherence and plausibility are both characteristics of the cultural approach to risk (Douglas and Wildavsky, 1982; Rayner, 1987; Schwarz & Thompson, 1990; Breakwell, 2007). According to this approach, cultural beliefs and world-views determine how people experience and interpret risks. Furthermore, cultural groups can be classified into four generic types: entrepreneurial, egalitarian, bureaucratic, and stratified individualistic. The entrepreneurial type interprets risks as an opportunity for advancement, whereas the egalitarians regard risks as an essential threat to group coherence and fairness. The bureaucrats accept risks as long as they have the assurance that society can manage them. Stratified individuals are most likely to pursue a Not-In-My-Back Yard (NIMBY) attitude and to perceive all risks imposed collectively on them as threats to their individuality. Each of the four cultural types develops its own criteria and selection rules for constructing a group-specific interpretation of risk. How people experience risk is thus a function of their cultural beliefs and values.

This claim has drawn fire from many analysts (cf. Johnson, 1987; Sjöberg, 1997). First, depending on the social role they play, individuals may belong to different cultural groups. For example, a corporate manager (entrepreneurial role) may belong to a religious group emphasizing egalitarian values and solidarity. Second, being a member of one cultural group does not preclude the capability to understand and accept the rationales of other groups as different but equally legitimate ways of dealing with the issue. Third, and most important, empirical proof for the existence of these groups let alone any convincing evidence about the claim of mutual exclusiveness, is still weak.

From this review it becomes evident that we still lack a coherent and consistent model of how individuals perceive and evaluate risks. Therefore, the paper suggests a nested approach by which cognitive, affective, heuristic factors on the individual level interact with social, economic and cultural context factors on the aggregate levels. Micro- and macro-level are mediated by specific institutions and organizations that help individuals to articulate their concerns, develop beliefs and attitudes and legitimate their behavioural reactions. This chain of individual perception, organisational and institutional setting and macro-level values and orientations is also responsible for the direct and indirect links between perception and vulnerability. Since perceptions and habits determine how people will act, they inadvertently shape the nature of the response actions in face of natural hazards or pending disasters. If people underestimate the intensity of the threat they may not take the necessary cautionary actions to protect themselves. Or vice versa: if they overestimate a specific hazard they may spend far too many resources on reducing only minimal risks. In addition, depending on the

perceived nature of the hazard they may misjudge the appropriateness of specific protective behaviour or options for mitigation.

The review also highlighted the differences between risk perception of technological and natural hazards. People in modern technology-dominated countries tend to underestimate natural hazards as they regard nature as a benign and endangered counterpart to the overwhelming technologically transformed urbanity (Renn, 2008: 113). In spite of the recent major natural disasters such as the earthquake in Haiti and the tsunami in East-Asia most Westerners believe that many more people are affected by natural and habitual risks than by natural hazards (Swiss Re 2010). Furthermore, as the review revealed, only a few of the typical psychometric attributes are powerful predictors for natural hazard perceptions. However, as the Elbe case study demonstrated the institutional arrangements, in particular the conviction of whether the individual or a social organization is responsible for protection, are very important not only for risk perception itself but also for how risks are managed. This attitude towards responsibility and accountability has a direct influence on the overall vulnerability of the system. Last not least the review also clarified the customary distinction between experts and laypersons. For natural hazards such a dichotomous distinction is empirically doubtful. Risk perception is a conglomerate of acknowledged systematic expertise, personal experience, local tacit knowledge and intuition. The more people have experienced natural disaster the more this experience shapes their perceptions. The more remote they are from natural disasters the more they judge the risks according to the conveyed expertise in the media and their own intuitions. Again this mixture of different knowledge pools is highly relevant for vulnerability. If experiences are lacking people tend to underestimate the probability of a disaster and will not invest in protective actions.

The final part of the paper touched upon the question of how to use perception studies for reducing vulnerability and increasing resilience. The emphasis here was on improved risk communication and stakeholder and public involvement. Based on the three major challenges of knowledge about natural hazards, i.e. complexity, uncertainty, and ambiguity (Renn, 2008: 334) it is useful to distinguish between epistemological, reflective and participatory types of discourse (Renn 2009).

Within the epistemological discourse, ambiguities about knowledge claims need to be addressed and – if possible -- resolved. At least, a portfolio of knowledge-based assessments and evaluations should be produced in order to set a demarcation line between knowledge, stochastic modelling, educated guesses, and pure fantasy. The postmodern belief that there are no universal standards of quality or universal criteria for standards of truth may be devastating if one wants to increase resilience. In reality, people suffer and die as a result of false knowledge. Because in environmental and risk decision-making, knowledge of the consequences embraces a whole spectrum of legitimate claims on the truth, the boundaries of methodologically verifiable knowledge must be identified as clearly as possible. This is especially the case with the new complexity associated with the mix of natural and human-induced hazards. The epistemological discourse is the platform where such a search for truth claims and their redemption can take place.

The epistemological discourse should lead to what we call a reflective discourse dealing with unresolved uncertainties. Under most circumstances in which natural hazards occur many uncertainties remain unresolved which requires a precautionary risk assessment and

management approach. How can one judge the severity of a situation when the potential damage and its probability are unknown or contested? Somebody needs to set the right balance between over- and underprotection. This balancing act necessitates a type of discourse between those who suffer from being potentially under-protected or those who would pay an unnecessarily high amount for measures of potential over-protection. Dealing with uncertainty in a complex natural hazard field requires delicate negotiations among all affected actors and a clear attribution of responsibility for taking actions in to protect oneself and others in the case of a disaster.

Ambiguity over values and social visions require a third kind of discourse, called participatory. Participatory discourses include legal deliberations as well as novel approaches to include stakeholders and representatives of the public at large. If value conflicts are associated with measures to mitigate or reduce the impacts of natural hazards (such as zoning, technical facilities to protect people or natural buffers), it is not enough to demonstrate that public planners are open to public concerns and address the issues that many people wish them to take care of. The process of assigning tradeoffs between each of the options needs to be open to public input and new forms of deliberation.

For the upcoming years, research on the link between risk perception and vulnerability has still a full agenda as demonstrated with this paper as well as many other topical publications on natural hazard. As much as natural hazard protection depends on better models and more accurate risk assessments, the input from the social sciences is crucial for informing policy makers about public concerns and perceptions, including proven links between individual behaviour and vulnerability into action plans for resilience, developing better methods of mutual risk communication, and providing effective models for the three types of discourse needed to bring the technical analyses in line with the social and cultural needs of the respective societies.

Discursive debate that incorporates the best available knowledge of the consequences and the preferences of the people affected enables competent and fair decision-making. Discourse devoid of systematic knowledge principles has no content; discourse that overshadows the moral quality of the various options for action is reduced to mere expertocracy. The requirements of discourse are transparency of the outcome, a clear mandate and mandatory verification of knowledge elements and ethical standards. Thus, where expertise is taken into account, when the boundaries of economic efficiency are acknowledged and the legal room for manoeuvre is not overstepped, people’s perceptions can take on an important action-driving part in how resilience can be steadily improved.

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Annex A: European risk perception studies

France

Heitz, C, Spaeter, S, Auzet, AV, Glatron, S. Local Stakeholders' Perception of Muddy Flood Risk and Implications for Management Approaches: A case study in Alsace (France). Land Use Policy 2009, 26: 443-451

Main research questions

How do local stakeholders perceive muddy flood risk? Which social factors have to be taken into account when designing policy options for managing muddy flood risk management policy?

Outcomes investigated

Risk perception of individual stakeholders

Factors explored

Knowledge factors: Location within the catchment, trust in information

Main insights

Risk perception of individuals depends on their location in the catchment. Type and source of information also have an impact, mainly due to the differences in the perceived trustworthiness of the public authorities providing information

Comments

This study shows individual and professional differences between stakeholders (local authorities, inhabitants, farmers) in risk perception. There are differences between the stakeholder-groups in the perception of the important factors triggering muddy floods, but the strongest factor is the flood experience of the individuals, represented in the location in areas with often occurring muddy floods.

Ruin, I, Gaillard, JC, Lutoff: How to get there? Assessing motorists' flash flood risk perception on daily itineraries. Environmental hazards 2007, 7: 235-244

Main research questions

Are drivers aware of severe storm and flash flood risks? What are the factors determining their risk perception?

Outcomes investigated

Risk perception of individual drivers

Factors explored

Danger in road sections (GIS-variables and cognitive maps), age, profession, family status, area of living, flood experience

Main insights

The perception of danger of driving during a storm is dependent on age, profession, family status, area of living and flood experience: People aged under 25 and over 45, singles and people without flood experience underestimate the danger of a specific road section, people with flood experience seem to overestimate the danger

Comments

Drivers are an important group at risk, it is interesting to know more about their risk perception from this survey. It classifies the correlation into “over” or “underestimation” with respect to the real danger of the specific road section: Risk perception is high when dealing with short daily itineraries within a perimeter close to the place of residence. Risk perception maps provide useful operational data for risk managers.

Germany

Plapp, T, Werner, U. Understanding Risk Perception from Natural Hazards: Examples from Germany. RISK 2006, 21: 101-108.

Main research questions

What are the factors influencing natural hazard risk perception in Germany? Do these perceptions differ for various types of hazards (storm, earthquake, floods) and differ for general risk perception and for personal risk perception?

Outcomes investigated

General flood risk perception, general windstorm perception, general earthquake perception, personal risk perception

Factors explored

Perceived personal risk, fear evoked by the risk, familiarity of hazard, likelihood of fatal consequences, frequency of hazardous event, age, educational level, gender, world wievs

Main insights

The most important factors for general risk perception are perceived personal risk, fear evoked by the risk, familiarity of hazards to those exposed, likelihood of hazardous event and fatal consequences. Personal risk perception is highly influenced by personal experience with natural hazards. Gender and world views play a minor role.

Comments

The study focuses on differences between general risk perception and personal risk perception: Earthquake is most often subsumed under general risk, floods under personal risk. Personal experience is the most influential parameter for assessing personal risks from natural hazards.

Felgentreff, C: Post-Disaster Situations as "Windows of Opportunity"? Post-Flood Perceptions and Changes in the German Odra River Region after the 1997 Flood. Die Erde 2003, 134: 163–180.

Main research questions

Does risk perception change after a flood-event?

Outcomes investigated

Perception of flood risk after a flood event

Factors explored

Experience of a flood event, media reports of a second flood event

Main insights

Risk perception and risk awareness reach higher levels after a flood event, but soon drop back to average levels. The "window of opportunity" after a flood-event can be used to plan and market new mitigation-strategies. However, it is essential to have people recall the experience of the flood for initiating protective actions.

Comments

Only the abstract of this paper was available.

Grothmann, T, Reusswig, F: People at Risk of Flooding: Why Some Residents Take Precautionary Action While Others Do Not. Natural Hazards 2006, 38: 101-120.

Main research questions

Why do some residents of flood risk areas take precautionary action while others do not?

Outcomes investigated

Private efforts for taking precautionary measures for damage prevention

Factors explored

Perception of flood risk experience, perceived risk of future floods, perceived reliability of public flood protection, perceived efficacy and costs of protective behaviour, perceived ability to perform these actions, non-protective responses (like fatalism, denial, wishful thinking)

Main insights

The most important factors prompting precautionary measures relate to individual perception rather than (objective) economic impacts. Two factors dominate the motivation to invest in protection: previous flood exposure and home ownership .

Comments

The comparison between the explanatory values of a socio-psychological model based on protection motivation and the socio-economic model (including factors of age, gender, income, school degree and ownership) demonstrated a better model fit for the socio-psychological model

Kämpf, C, Ulbrich,T, Müller, M, Ihringer, J: Effective Early Warning System On Flooding For Stakeholder's Use. In: W. Ammann, J. Haig, C. Houvinen, M. Stocker : *IDRC Davos 2006 Vol 2 Extended Abstracts A-R. Invited Session's Extended Abstracts,* Davos: Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf (WSL): 245-247.

Main research questions

Which communication mode is most effective for the distribution of flood-risk related information (online vs. print)? What kind of information is relevant for the public on a local or regional level for social action?

Outcomes investigated

Information for various phases of the flood management process: mitigation, preparedness, response, recovery, assessment (lessons learned);

Factors explored

Memory (time lapse after last flood), frequency of exposure to floods

***Main insights**:*

Methods applied: text analysis, document design, expert interviews, focus group interviews). Optimization of flood risk related documents for the public according to four categories: accessibility of information, technical functionality (for online sources), content, readability (interaction of text and visuals; maps; Gestalt principles).

Comments

First report only, provided by the authors

Kaiser, G and Witzki, D: Public perception of coastal flood defence and participation in coastal flood defence planning – in: Schernewski, G and Dolch, H. : Geographie der Meere und Küsten. Coastline report 2004 1: 101-108

Main research questions

Are there differences in the perception of coastal floods between European countries? How can public perception of coastal flood risks be changed?

Outcomes investigated

Risk perception, risk awareness, willingness to act

Factors explored

Country: (North sea region): Belgium, United Kingdom, Denmark, The Netherlands, Germany

Main insights

Risk perception and awareness differ between countries. To the question “Do you know what to do in case of coastal flooding?” about two thirds of the people in all countries answered “no”, in Denmark 68% answered with “Yes”. Around 30% of the respondents expressed their willingness to participate actively in a coastal defence planning process.

Comments

First report only

Keibich, H, Thieken, A H, Grunenberg, H, Ullrich, K, Sommer, T: Extent, perception and mitigation of damage due to high groundwater levels in the city of Dresden, Germany. Natural Hazards and Earth System Sciences 2009 9: 1247–1258.

Main research questions

Do people with flood experience perceive groundwater flooding as more dangerous than those without this experience?

Outcomes investigated

Risk perception of groundwater flooding in Germany, perception of responsibility of different groups, attractiveness of precautionary and emergency measures

Factors explored

Personal experience (groundwater floods, mixed floods), experienced damage,

Self-rated informational level

Main insights

Risk perception of groundwater flooding is independent of personal experience with floods. Groundwater floods are not included in the decision process for personal protection. Authorities are seen to be responsible for initiating protective measures. Only a few households undertake emergency measures when expecting a groundwater flood

Comments

It is interesting that there is hardly any awareness of groundwater flood risks even among those who have experienced floods in the past. 70% of the interviewed people are, however, interested in receiving more information. Recommendations for risk information are: focus on individual prevention; raising awareness not only by pointing out the possible economic losses but also the ideal losses after a groundwater flood. People who have not experienced groundwater flooding should be particularly addressed.

Iceland

Jóhannesdóttir, G, Gísladóttir, G: People living under threat of volcanic hazard in southern Iceland: vulnerability and risk perception. Natural Hazards and Earth System Sciences 2010: 10: 407-420.

Main research questions

How do people perceive volcanic risks (eruption, ash fall, flood, tsunami) in an area, where an eruption has taken place?

Outcomes investigated

Perception of volcanic risk

Factors explored

Age, experience of an eruption, region, vulnerability

Main insights

At the beginning of the interviews people do not believe scientists' warnings, but within the 2 hours of the interview some people began to think about the danger in a different way and became more risk-aware. The perception of one's own vulnerability is low and therefore no personal mitigation or disaster preparedness plans have been made.

Comments

Qualitative results from 28 in-depth interviews, insights were derived from stories told, implications for risk communication are given: Personal contact with scientists and the chance to speak about the volcanic risk could raise awareness.

Italy

Barberi, F, Davis, MS, Isaia, R, Nave, R, Ricci, T. Volcanic Risk Perception in the Vesuvius Population. Journal of volcanology and geothermal research 2008, 172/3-4: 244-258.

Main research questions

How do people in the Vesuvius area perceive volcanic risk? Which factors are important for explaining their risk perception?

Outcomes investigated

Volcanic risk perception, perception of their own vulnerability, preparedness, trust in authorities

Factors explored

Age, gender, educational level, amount of information given, confidence in evacuation plan and in the government

Main insights

People are aware of the volcanic risk within the area and of their vulnerability. No clear patterns have been observed between risk perception and confidence in scientists' ability to provide accurate information, or between risk perception and age and gender, but women seem to be more worried about a possible eruption

Comments

The study offers insights into the perception of their own vulnerability: people know that an eruption is likely and will have serious consequences for themselves, but they have other risks to worry about (social, economic and security-associated issues were mentioned).

Stanghellini, LPS, Collentine, D: Stakeholder discourse and water management – implementation of the participatory model CATCH in a Northern Italian alpine sub-catchment. Hydrology and Earth System Sciences 2008, 12: 317-331.

Main research questions

What are the outcomes of the participatory CATCH-model? Are ordinary citizens able to identify and evaluate measures for improving management practices for a river-catchment?

Outcomes investigated

Awareness of citizens (results collected from focus groups)

Factors explored

Socio-economic as well as environmental variables: Use of water (domestic, agricultural, touristic), biodiversity, vulnerability of fresh water supply by wells, availability of water (identified by the participants of a public workshop)

Main insights

Risk awareness of citizens has a positive effect on most of the socio-economic environmental variables: Positive change, which means using less water (domestic use, agricultural use and touristic use), had a positive effect on water availability, biodiversity and spring vulnerability, a negative change had a negative effect on these factors

Comments

Whereas the focus of the paper is on stakeholder discourse and water management, the analysis of the workshop results is also very comprehensive regarding the behavioural changes triggered by raising public awareness. Participation in the workshop produced changes among the participants for a variety of variables, including water use and environmental parameters (biodiversity, spring vulnerability).

Jurt, C: Perceptions of Natural Hazards in the Context of Social, Cultural, Economic and Political Risks. A case study in South Tyrol. Eidgenössische Forschungsanstalt WSL 2009.

Main research questions

How do contextual variables (in particular space and time) influence risk perceptions of natural hazards?

Outcomes investigated

Detailed perception of different risks, focus on avalanches

Factors explored

Region, gender, personal experience, local knowledge (based on oral history), trust

Main insights

Risk perception dependency on single factors could not be quantified: perceptions of natural hazards are embedded in more encompassing risk discourses, including economic, social, cultural and political risks.

Comments

The study combines a quantitative and qualitative approach; a major result is that individual risk perception is a multi-layered-process.

Castelberg, F: Wahrnehmung und Bewertung von Naturgefahren, Diplomarbeit 1997, Universität Bern.

Main research questions

How do people perceive natural hazards in a multi-hazard region?

Outcomes investigated

Perception of storms, avalanches, flash floods and stone slides; perception of one's own vulnerability

Factors explored

Historical factors, lay knowledge

Main insights

The different natural hazards are not perceived as dreadful, most respondents believed they could cope with them. One exception is heavy storm. Technical measures are preferred by lay people over natural protection measures of river plains.

Comments

Lay knowledge embedded in historical stories is impressive (see also Jóhannesdóttir, G et al., 2010).

Miceli, R, Sotgiu, I, Settanni, M. Disaster Preparedness and Perception of Flood Risk: A Study in an Alpine Valley in Italy. Journal of Environmental Psychology 2008, 28: 164-173.

Main research questions

How does the perception of flood risk influence disaster preparedness?

Outcomes investigated

1. Perception of flood risks: a) based on likelihood estimates and b) based on feelings of worry 2. Adoption of protective behaviour

Factors explored

Age, gender, level of education, experience of damage, level of feeling informed, participation level, closeness to the waterfront, adoption of protective behaviour

Main insights

Perception is significantly correlated with personal experience of damage in an earlier flood. Women perceive a higher level of risk than men, younger people showed a higher perception level than older people. A positive and significant relationship between feelings of worry and the adoption of protective behaviours was observed (but not between likelihood judgements and the adoption of protective behaviour)

Comments

A very detailed analysis of disaster preparedness and different forms of risk perception: perception of likelihood seems not to be a factor determining disaster preparedness, but feelings of worry are.

Netherlands

Baan, PJA, Klijn, F. Flood risk perception and implications for flood risk management in the Netherlands. International Journal of River Basin Management 2004, 2: 113–122.

Main research questions

How do people feel about living alongside rivers (concerns and fears)?

Outcomes investigated

Perception of flood risks compared to others (smoking, nuclear plant, bee sting, road traffic)

Factors explored

Perceived fairness in risk-benefit distribution, familiarity with the risk, reason for exposure to risk, seriousness of the effect, degree of control and preparedness

Main insights

Floods are seen as highly risky, even if their probability is low: They are not seen as voluntary, but as complex and serious (disasters are possible). But they are not seen as purposeful, (which would be more threatening).

Comments

A very comprehensive review paper, but there is little reference to original data. Important discussion about a possible change in perception of floods, which would occur after information about inundating calamity polders on purpose to protect more downstream areas: are floods then seen as "man made" and a voluntary risk taken? See also Sjöberg (2006)

Terpstra, T . Flood preparedness: thoughts, feelings and intentions of the Dutch public. Ph.D. Thesis University of Twente 2009.

Main research questions

What are the predictors of flood preparedness among Dutch citizens? Do higher risk perceptions increase citizens' intentions to be more prepared for floods? Do higher levels of trust have a negative impact on citizens' risk perceptions and intentions to be prepared?

Outcomes investigated

Perceived dread, perceived consequences of floods, perceived likelihood, intentions to be more prepared for floods

Factors explored

Feelings associated with previous experience of floods, trust in flood protection agencies

Main insights

Perceptions of flood consequences play a marginal role for individual intentions to be more prepared for floods. More important is perceived likelihood and perceived dread. Trust in flood protection lessens perceptions of flood likelihood and dread and through this route, reduces intentions to be more prepared for floods. Negative feelings associated with previous experience decrease trust in official flood protection measures and increase risk perceptions, positive feelings increase trust in authorities and decrease risk perception.

Comments

The causal chain starting from trust via-risk perception to personal preparedness runs counter to other studies on the same subject; the role of dread, likelihood, and consequences is also in contrast to other studies (Sjöberg 2006): where perceived consequences were identified as the most important factors

Slinger, J, Cuppen, M, Muller, M, Hendriks, M. How responsive are scientists and policy makers to the perceptions of Dutch and Flemish citizens living alongside the Scheldt Estuary?. Insights on Flood Risk Management from the Netherlands, 2007.

Main research questions

Does the perception of flood risk and prevention measures change after attending informational workshops? How responsive are scientists and policy makers to the perception of citizens living in flood prone areas?

Outcomes investigated

a) Flood risk perception of citizens and scientists b) Responsiveness of scientists and policy makers to the perception of local inhabitants

Factors explored

Shifts in opinions of citizens, scientists and policy makers

Main insights

Understanding of flood risk is similar in both groups, but the citizens had deeper insights regarding the consequences of flooding and the recovery thereafter than the experts. Both the public and the scientists were willing to change their opinions and also their behaviour once they were confronted with information on exposure, consequences and protective measures: After the workshops the citizens voted less positive on technical measures and indicated that they wished the policy makers to spread their attention more evenly over the flood risk management phases

Comments

The interaction between scientists, policy makers and the public at the workshop lead to a better knowledge of the probable evacuation behaviour (on the scientists' side) and of the flood risk management phases (on the citizens' side). It can be concluded that connecting local knowledge with the knowledge of scientists and policy makers is able to influence the policy debate and to help to create better flood management plans.

Norway

Krasovskaia, I, Gottschalk,L, Saelthun, N, Berg, H: Perception of the risk of flooding: the case of the 1995 flood in Norway. Hydrological Sciences-Journal 2001, 46/6: 855-868.

Main research questions

How does the public perceive flood risks?

Outcomes investigated

a) Perception of risk for life and health b) of economic and environmental loss

Factors explored

Public versus expert panel (decision makers), “river affinity”, nationality

Main insights

The perception of flood risks by the general public does not match the results from statistical analysis – people underestimate the risks to life and health. Decision makers have poor insight into economic issues of flood mitigation

Comments

The authors collected data from 900 phone-interviews They also give advice for improved risk communication: for example training tools for decision makers, checklists for risk estimation during a flood and operational decision support tools, based on participatory principles

Romania

Armas, I. Social vulnerability and seismic risk perception. Case study: the historic center of the Bucharest Municipality/Romania. Natural Hazards 2007, 47: 397–410.

Main research questions

Does social vulnerability influence the level of perception of a seismic risk?

Outcomes investigated

Perception of a seismic risk

Factors explored

Social vulnerability (normalized composed index of two samples: Poverty ratio and demographic vulnerability ratio, depending on age, gender and education level)

Main insights

A significant positive correlation between social vulnerability and seismic risk perception was obtained

Comments

A clear correlation between vulnerability and perception, but there is no discussion on the reasons and circumstances under which this relationship holds true

Armas, I, Avram, E. Perception of flood risk in the Danube Delta, Romania. Nat Hazard 2009, 50: 269-287.

Main research questions

What are the psychological factors influencing the perception of flood risks in the Danube Delta?

Outcomes investigated

Perception of flood risks measured on a scale of 30 different items (connected with personal feelings, fear, trust, perceived own vulnerability): These variables are also tested against each other

Factors explored

Age, gender, religiousness, years of formal education, income, type of support expected, professional activism, ownership status, also the different items of flood perception are tested as factors.

Main insights

Two psychological factors (an internal and an external factor) are essential in establishing the personal degree of psychological vulnerability. Persons with “inner control” are less anxious. As confidence in one’s own agency diminishes, it increases the tendency to rely on external factors for advice, institutional support and security

Comments

The finding that non-adaptive behaviours are emphasised by the lack of resources and mistrust in the authorities stands in contrast to the results of Terpstra, possibly due to the different political systems.

Slovenia

Brilly, M, Polic, M. Public Perception of Flood Risks, Flood Forecasting and Mitigation. Natural Hazards and Earth System Sciences 2005, 5: 345-355.

Main research questions

What factors influence flood perception?

Outcomes investigated

Flood risk perception: perceived threat (visualized on self-drawn maps), and concerns related to floods

Factors explored

Experience with floods, geographical areas, perceived probability of floods occurring

Main insights

The perception of flood threat depends on the place of residence (flood prone areas). The willingness to take measures against floods was not significantly correlated with the level of personal concern. The place of residence was a better predictor for preparedness than the perceived probability

Comments

Data were derived from a survey in two different regions with interesting visualisation-methods to test perception. People seem to perceive geographical distribution of risks in a more specific way than time distribution (probability) and therefore are more willing to act when they live in a dangerous area.

Spain

Raajmakers, R, Krywkow, J and van der Veen, A. Flood risk perceptions and spatial multi-criteria analysis: an exploratory research for hazard mitigation. Nat. Hazards 2008, 46: 307-322

Main research questions

How does risk perception differ between stakeholder groups of the Ebro-Delta? How can the notion of trade-off between perceived risk and benefits be applied to natural hazards? How can risk perceptions be inserted into spatial multi-criteria analyses?

Outcomes investigated

Flood risk perception, characterized by the notions of awareness, worry and preparedness

Factors explored

Stakeholder groups of the Ebro-Delta: The rice farmers association, the water distribution cooperative, the salt manufacturer, the tourism industry, local and regional authorities and park managers.

Main insights

Private stakeholders are less worried than public stakeholders. Laypeople did not know what to do in case of flooding, but their level of worry was higher. Risk perception results, especially worries, may be used to determine the positioning of societal preferences with respect to either risk reduction or the conservation of benefits. They can be translated into a weighting for spatial multi-criteria analysis.

Comments

This study is an attempt to combine technical expertise with social risk perception. It helps to explain the influence of flood risk perception on risk-benefit trade-offs. The authors recommend, that the variables have to be weighed in a participatory process, incorporating the variety of stakeholder preferences towards risks and benefits.

Sweden

Sjöberg, L. Perceived risk and tampering with nature. Journal of Risk Research 2000, 3/4: 353-367.

Main research questions

Is the association of unnaturalness a strong factor in risk perception of potential nuclear disasters?

Outcomes investigated

Perception of a disaster risk (nuclear disasters), new and unknown risk, perceived dread by politicians and the public

Factors explored

Tampering with nature, sex, age, age of youngest child, income, educational level, size of community,

Main insights

Tampering with nature was the strongest predictor of perceived risk (stronger than the traditional psychometric model dimensions)

Comments

The results of observations regarding a non-natural hazard are mentioned here because of their implications on the perception of “man made floods” (as they are discussed in Baan et al., 2004).

Switzerland

Siegrist, M, Gutscher, H. Flooding Risks: A Comparison of Lay People's Perceptions and Experts’ Assessments in Switzerland. Risk Analysis 2006, 26/4: 971-979.

Main research questions

Do lay people perceive flood risks differently from experts?

Outcomes investigated

Perceived risk, prevention behaviour

Factors explored

Area (German or French-speaking area, mountain, urban, hazard area), age, gender home ownership, past experience, involved in cleaning up after a disaster

Main insights

Respondents’ risk perceptions were positively correlated with the experts’ risk assessment, the strength of the relationship differs across regions: experience of floods is a strong factor influencing both the perception and the prevention behaviour

Comments

Major attempt to simultaneously assess two factors: experience of floods and statistically measured risk as a function of two dependent variables: perceived risk and self-declared prevention behaviour. Implications for risk communication are shown (mass media seem to be less important)

Siegrist, M, Gutscher, H: Natural Hazards and Motivation for Mitigation Behavior: People Cannot Predict the Affect Evoked by a Severe Flood. Risk Analysis 2008, 28(3): 771-778.

Main research questions

Do people without flooding experience underestimate the consequences of such an event?

Outcomes investigated

Perception of the effects of a flood, precautionary measures

Factors explored

Flooding experience: people who were affected by a severe recent flood disaster versus people not affected but living in flood-prone areas

Main insights

People who were not affected strongly underestimate the negative emotional stress (affects) associated with a flood

Comments

The publication emphasises the importance of risk communication to help people to envisage the negative emotional consequences of natural disasters.

Cross-cultural

Plattner, Th., Plapp, T. and Hebel, B: Integrating public risk perception into formal natural hazard risk assessment. Nat. Hazards Earth Syst. Sci. 2006, 6: 471-483.

Main research questions

How can risk perception of natural hazards be quantified?

Outcomes investigated

Personal risk perception

Factors explored

Perception affecting factors: effective individual risk, voluntariness of risk-taking, individual options to reduce risk, knowledge and experience with risk source, endangerment (likelihood to die, fear evoked), subjective damage rating, subjective flood recurrence frequency

Main insights

Comparing the weights of factors that influence risk perception by different methods (workshops with experts, workshops with laypersons and open questionnaires) supports the assumption that these factors can be quantified and transferred into a formal model. The risk perception model provides fairly robust results.

Comments

An impressive approach to quantify and model individual risk perception. As the model is based on the psychometric paradigm it can only explain how risk perception differs, but not why. And it is only a snapshot of the actual perception and the determining factors.

Heijmans, A. Vulnerability: a matter of perception. Benfield Grelg Hazard Research Centre. London. Disaster Management Working Paper 2001, 4: 1-17.

Main research questions

How does information influence risk perception and vulnerability?

Outcomes investigated

Risk perception (floods, volcanic), vulnerability

Factors explored

Experience with natural hazards, credibility of the warning source, kind of preparedness, coping measures

Main insights

The degree of perception of the risk differs greatly between households and therefore influences the vulnerability and, as a consequence, the willingness to take special action: if people expect worse living conditions after evacuation, or if they are afraid that they cannot protect their property if they leave then they will stay in a risky area as long as possible.

Comments

The paper lists short examples of the connection between perception and vulnerability in different cultures. It is mentioned that participation is essential for risk management of communities, to take into account the different perception of the households.

Barnes, P. Approaches to community safety: risk perception and social meaning. Australian Journal of Emergency Management 2002, 17.

Main research questions

What are the reactions of a community in case of a natural hazard (compared to other risks)? What is the role of risk perception?

Outcomes investigated

Risk perception of different hazards

Factors explored

Familiarity, control, voluntary exposure, experience, “placebo-effect”

Main insights

The effects of a natural hazard event in a community are severe and cause (via perception) changes in different social components (“feeling safe” , trust in authorities, behaviour of the people, “self-therapeutic community”)

Comments

This review-paper focuses on the chasm between the beneficiaries of regulation and the regulators, based on distrust in authorities.

Annex B: Mapping research activities and practices in the field of risk perception of natural hazards in Europe

Country	Natural hazard	Scale: national, regional, local, households	Concrete event?	Research or practice?	Contact Details	Remark and Literature
1 Austria	snow avalanche	local?		research and practice	Marion Schulte zu Berge M.Schultezuberge@liverpool.ac.uk	Diploma thesis, published as book: Lawinenrisiko in den Tiroler Alpen. Wissen und Wahrnehmung von Einheimischen und Experten. Saarbrücken: VDM, 2008 (risk perception of 'indigenous' population and of avalanche experts)
	Alpine land slides	local	Salsbourg, Plurs	research and practice	Katrin Hauer	Katrin Hauer, Der plötzliche Tod. Bergstürze in Salzburg und Plurs kulturhistorisch betrachtet, LIT Verlag: Münster-Hamburg-Berlin-Wien-London-Zürich 2009.
	Flooding	local national: Austria, Germany, France		research and practice	Helmut Habersack (Joint project Co-ordinator)	ERA-NET CRUE Funding Initiative on Flood Risk Management Research: Risk Assessment and Risk Management: Effectiveness and Efficiency of Non-structural Flood Risk Management Measures (2008); http://www.crue-eranet.net/partner_area/documents/Final_Report_PRO_Floodplain.pdf
2 Belarus						
3 Belgium	Flooding		Scheldt Estuary		Slinger, J,	Slinger, J, Cuppen, M, Muller, M, Hendriks, M. How responsive are scientists and policy makers to the perceptions of Dutch and Flemish citizens living alongside the Scheldt Estuary?. Insights on Flood Risk Management from the Netherlands, 2007
4 Bosnia and Herze-govina						
5 Bulgaria		national			Ortwin Renn renn@dialogik-expert.de	Sjöberg, L, Kolarova, D, Rucai, AA, Bernström, ML. Risk perception in Bulgaria and Romania. In Renn, O, Rohrmann, B, ed. Cross-Cultural Risk Perception: A Survey of Research Results. Kluwer, Dordrecht and Boston, 2000, 145–184.
6 Croatia						
7 Cyprus						
8 Czech Republic	Flooding	local	1997 Morava	research really		Strachová, A. (1999): in Vaishar, A. (1999): Povodně, krajina a lidé

Country	Natural hazard	Scale: national, regional, local, households	Concrete event?	Research or practice?	Contact Details	Remark and Literature
			flooding	conducted?		v povodí řeky Moravy. 1. díl. Brno.
9 Denmark						
10 Estonia						
11 Finland						
12 France	Different hazards				Roland Nussbaum	Risk Perception Barometer (IRSN)
	Heat waves		Heat wave France 2003	research	Poumadrere	Poumadère, M, Mays, C, Le Mer, S, Blong, R. The 2003 Heat Wave in France: Dangerous Climate Change Here and Now. Risk Analysis 2005, 25/6:1483-1494. (amplification and attenuation of risks)
				research	Thierry Coanus	Coanus T., Comby J., Duchêne F., Martinais E. (dir.), 2010, Risques et territoires. Interroger et comprendre la dimension locale de quelques risques contemporain, Lavoisier, Paris, 480 p. (under press)
	Mud flood		Alsace	research		Heitz, C, Spaeter, S, Auzet, AV, Glatron, S. Local Stakeholders' Perception of Muddy Flood Risk and Implications for Management Approaches: A case study in Alsace (France). Land Use Policy 2009, 26:443-451
	Flash floods, Storms		Southern France	research	Isabelle Ruin Isabelle.ruin@laposte.net	Ruin, I, Gaillard, JC, Lutoff, C. Drivers' risk perception of severe storms hazards in Southern France. 4th European Conference on Severe Storms in Trieste, Grenoble, 2007.
13 Germany	flooding, windstorm, earthquake	regional	Inn, Rhine, Donau and others	Empirical research	Tina Kunz-Plapp	Plapp, T, Werner, U. Understanding Risk Perception from Natural Hazards: Examples from Germany. RISK 2006, 21: 101-108. Plapp, T. Wahrnehmung von Risiken aus Naturkatastrophen. Eine empirische Untersuchung in sechs gefährdeten Gebieten Süd- und Westdeutschlands. Karlsruhe: VVW Verlag Versicherungswirtschaft (Karlsruher Reihe II: Risikoforschung und Versicherungsmanagement; 2), 2004.

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	Flooding	regional?	1998 Oder flood	empirical research	Carsten Felgentreff	Felgentreff, C. (2003): Post-Disaster Situations as “Windows of Opportunity”? Post-Flood Perceptions and Changes in the German Odra River Region after the 1997 Flood. Die Erde 134, 163–180.
	Flooding		2002 Elbe flood	empirical research		Grothmann, T.; Reusswig, F. (2006): People at Risk of Flooding: Why Some Residents Take Precautionary Action While Others Do Not. Natural Hazards 38, 101-120.
	Flooding	local (Cologne)	Rhine	research	Xiaomeng Shen, via A. Fekete	http://hss.ulb.uni-bonn.de/2009/1856/1856.htm PhD thesis (China – Germany); Flood Risk Perception and Communication within Risk Management in Different Cultural Contexts – a Comparative Case Study between Wuhan,China and Cologne, Germany
	Coastal Flooding	Regional		empirical research	Kaiser, G., Reese, St., Sterr, H.-J., H. Markau	COMRISK - Common strategies to reduce the risk of storm floods in coastal lowlands - Subprojekt 3: Public perception of coastal flood defence and participation in coastal flood defence planning - Final Report. Department of Geography University of Kiel, Kiel.
	Coastal Flooding	Local/regional		empirical research	Peters, H.P. H. Heinrichs	Öffentliche Kommunikation über Klimawandel und Sturmflutrisiken: Bedeutungskonstruktion durch Experten, Journalisten und Bürger. In: Schriften des Forschungszentrums Jülich, Reihe Umwelt/Environment, 48.
	Coastal Flooding	Household/Regional		empirical research	Ratter, B.; Lange, M.; Sobiech, C.	http://www.gkss.de/imperia/md/content/gkss/zentrale_einrichtungen/bibliothek/berichte/2009/gkss_2009_10.pdf
	Natural Hazards	Hamburg	Elbe Flood	empirical research		http://www.gkss.de/institute/coastal_research/structure/system_analysis/KSO/projects/studien/006992/index_0006992.html Annual telephone survey conducted in Hamburg

Country	Natural hazard	Scale: national, regional, local, households	Concrete event?	Research or practice?	Contact Details	Remark and Literature
	Coastal Hazards	Hamburg		empirical research		http://spicosa-inline.databases.eucc-d.de/files/documents/00000891_finalCR14.pdf on Risk perception and acceptance of measures
	Ground Water	Dresden		empirical research	Kreibich, Heidi	Kreibich, H., Thieken, A. H., Grunenberg, H., Ullrich, K., Sommer, T. (2009): Extent, perception and mitigation of damage due to high groundwater levels in the city of Dresden, Germany. Natural Hazards and Earth System Sciences 9, 1247–1258.
	Flooding	Europe, all scales	Summer flooding 2003 in Europe	practice	Munich Re	Die Sommerüberschwemmungen 2003 in Europa, ein Jahrhunderthochwasser? Naturkatastrophen 2002, S. 17-25
	Flooding	regional	River Mulde, Saxonia, 2003	research	Meyer, Volker: Volker.meyer@ufz.de	Meyer, V, Haase, D, Scheuer, S. Flood Risk Assessment in European River Basins – Concept, Methods, and Challenges Exemplified at the Mulde River. Integrated Environmental Assessment and Management 2009, 5/1:17-26.
	Floods	regional	Floods of Odra, Rhine		WeichselgartnerJuergen	Weichselgartner, J. (2002): Naturgefahren als soziale Konstruktion – Eine geographische Beobachtung der gesellschaftlichen Auseinandersetzung mit Naturrisiken. Dissertation, Universität Bonn
	Droughts, heat waves	regional	Heat wave 2003	practice	Deutsches Kommitee Katastrophen-vorsorge	Deutsches Kommitee Katastrophenvorsorge – Gefahren erkennen, Schäden vermeiden Flyer 2004
	Droughts, heat waves	national	Heat wave 2003	practice	Munich re	Hitzesommer in Europa – die zukunft hat bereits begonnen. Topics Geo: Jahresrückblick Naturkatastrophen 2003, S. 27-31, 2004
	Alpine hazards	regional		practice	Berz, C	Globaler Klimawandel: Werden die Alpen zum Katastrophengebiet? Verein zum Schutz der Bergwelt, Jahrbuch 3006, S. 51-60, 2006
	Flash floods	Local (city quarters) households	Flash flood Hechingen 2008	empirical research	Kaempf, Charlotte charlotte.kaempf@kit.edu	Study in cooperation with Ulbrich, Thorsten thorsten.ulbrich@eurac.edu

Country	Natural hazard	Scale: national, regional, local, households	Concrete event?	Research or practice?	Contact Details	Remark and Literature
	Alpine hazards	regional	Heat wave 2003	practice	Munich re	Hitzesommer in Europa – die Zukunft hat bereits begonnen. Topics Geo: Jahresrückblick Naturkatastrophen 2003, S. 27-31, 2004
	All natural hazards	national		practice	Misereor	Weltkulturbuch – Globale Auswirkungen eines "Zukunftsfähigen Deutschlands" – Hinweise und Tips für unser tägliches Handeln. 211 S., Birkhäuser 1998
	All natural hazards			practice	Hauser, W. Deutsches Museeum München und Munich Re	Hauser, W.: Klima, das Experiment mit dem Planeten Erde. Begleitband zur Sonderausstellung des Deutschen Museeums München, 400 Seiten, 2002
14 Greece						
15 Hungary	Flooding	river basin? (Tisza)		research		Vari, A.; Ferencz, Z. (2006): Flood research from the social perspective: the case of the Tisza River in Hungary. In: Tchiguirinskaia, I.; Ni Ni Thein, K.; Hubert, P. (eds.): Frontiers in Flood Research: Le Point de la Recherche sur les Crues: Le Point De La Recherche Sur Les Crues. IAHS Press, 155-172 (IAHS Publication; 305).
16 Ireland						
17 Iceland	Landslides	regional	Bildudalur, NW-Iceland.		Bell, R,	Bell, R, Glade, T. Quantitative Risk Analysis for Landslides – Examples from Bildudalur, NW-Iceland. Natural Hazards and Earth System Sciences 2004, 4:117-131.
	Volcanic hazard	regional	Souther Iceland	Empirical research	Jóhannesdóttir, G,	Jóhannesdóttir, G, Gísladóttir, G: People living under threat of volcanic hazard in souther Iceland: vulnerability and risk perception. Natural Hazards and Earth System Sciences 2010: 10,407-420
18 Italy				empirical research	ISIG (FLOODsite)	De Marchi B., Scolobig A., Delli Zotti G., Del Zotto M. (2007). Risk construction and social vulnerability in an Italian Alpine Region. Report T11-07-12 of the Floodsite Integrated Project, http://www.floodsite.net
	Floods, Alpine hazards	household	Bozen, Neumarkt, Südtirol	empirical research	Link, Steffen	Link, S. Möglichkeiten und Grenzen der Öffentlichkeitsarbeit im Risikomanagement am Beispiel der Gefahrenzonenplanung in Südtirol. Masterarbeit, Innsbruck, 2008:1-5.

Country	Natural hazard	Scale: national, regional, local, households	Concrete event?	Research or practice?	Contact Details	Remark and Literature
	Volcanic hazards	regional		empirical research	Tullio Ricci: t.ricci@uniroma3.it	Davis,MS, Ricci, T, Mitchell, L: Perceptions of Risk for Volcanic Hazards at Vesuvio and Etna, Italy, The Australasian Journal of Disaster and Trauma Studies ISSN: 1174-4707.Volume : 2005-1 Barberi, F, Davis, MS, Isaia, R, Nave, R, Ricci, T. Volcanic Risk Perception in the Vesuvius Population. Journal of volcanology and geothermal research 2008, 172/3-4:244-258.
	Water management	Regional	Alta valsugana, Trento	empirical research	Stanghellini, LPS	Stanghellini, LPS, Collentine, D. Stakeholder discourse and water management – implementation of the participatory model CATCH in a Northern Italian alpine sub-catchment. Hydrology and Earth System Sciences 2008, 12:317-331. Perception in participation processes
	Landslides, Flooding	Regional	1998: 150 landslides in Avellino and Salerno, Campania 2000 North-West Italia	empirical research	Miceli Renato: miceli@psych.unito.it	Miceli, R, Sotgiu, I, Settanni, M. Disaster Preparedness and Perception of Flood Risk: A Study in an Alpine Valley in Italy. Journal of Environmental Psychology 2008, 28:164-173.
19 Latvia						
20 Lithuania						
21 Luxem-bourg						
22 Mace-donia						
23 Malta						
24 Moldova						
25 Monte-negro						
26 Nether-lands	flooding			research and practice		Baan, P. J. A.; Klijn, F. (2004): Flood risk perception and implications for flood risk management in the Netherlands. International Journal of River Basin Management 2, 113–122.

Country	Natural hazard	Scale: national, regional, local, households	Concrete event?	Research or practice?	Contact Details	Remark and Literature
	Flooding (Dutch coast, Rhine, Meuse, Lake Marken)	Individual household regional	protective action decision model	research	Teun Terpstra 2009 t.terpstra@hkv.nl	Flood preparedness: thoughts, feelings and intentions of the Dutch public. Thesis University of Twente 2009
	Flooding		Scheldt Estuary		Slinger, J	Slinger, J, Cuppen, M, Muller, M, Hendriks, M. How responsive are scientists and policy makers to the perceptions of Dutch and Flemish citizens living alongside the Scheldt Estuary?. Insights on Flood Risk Management from the Netherlands, 2007.
27 Norway	Flooding		1995 flood			Krasovskaia, I.: Perception of the risk of flooding: the case of the 1995 flood in Norway http://www.itia.ntua.gr/hsj/46/hysj_46_06_0855.pdf Hydrological Sciences-Journal 2001, 46/6:855-868.
28 Poland	Flooding, landslides, storms	national + different settlement types		research	Biernacki W., Działek J.	Biernacki W., Działek J., Janas K., Padło T. (2008): Community attitudes towards extreme phenomena relative to place of residence and previous experience. In: Liszewski, S. (ed.): The influence of Extreme Phenomena on the Natural Environment and Human Living Conditions. Łódzkie Towarzystwo Naukowe, 207-237.
29 Portugal						
30 Romania	Flooding	individual, local regional	Bucharest earthquakes: 1944, 1977, 1986, 1990 (Danube delta), landslides (Romania)	empirical research	luliaarmas@yahoo.com Armas 2009	Armas, I. (2007): Social vulnerability and seismic risk perception. Case study: the historic center of the Bucharest Municipality/Romania. Natural Hazards 47, 397–410. Armas, I. (2008): Perceptia riscului natural: cutremure, inundatii, alunecari de teren. Bucuresti.
31 Serbia						
32 Slovakia						
33 Slovenia	Flooding		Floods in Celje 1990 and 1998	empirical research	Polic, M.	Brilly, M, Polic, M. Public Perception of Flood Risks, Flood Forecasting and Mitigation. Natural Hazards and Earth System Sciences 2005, 5:345-355.

Country	Natural hazard	Scale: national, regional, local, households	Concrete event?	Research or practice?	Contact Details	Remark and Literature
34 Spain	See level rise	regional	Ebro Delta	research	Raajmakers, R:	Raajmakers, R, Krywkow, J and van der Veen, Anne: Flood risk perceptions and spatial multi-criteria analysis: an exploratory research for hazard mitigation. Nat. Hazards (2008):46:307-322
35 Sweden	All Natural Hazards	individual	Different Swedish Cities and regions	empirical research	Sjöberg, Lennart Lennart.Sjoberg@hhs.se	Sjöberg, L. Perceived risk and tampering with nature. Journal of Risk Research 2000, 3/4:353-367.
36 Switzer-land				research	Michael Bründl/ Ch. Reinberger bruendl@slf.ch	Perception of high probability/low consequences vs. low probability/high consequence events (risk aversion)
	Alpine hazards, flooding	Regional national	1500-2000	practice	Pfister, C.	Pfister, C. (ed.): Am Tag danach – Zur Bewältigung von Naturkatastrophen in der Schweiz 1500-2000. 263 S. Verlag Paul Haupt, 2002
	flooding	regional		research	Siegrist, Michael siegrist@sozpsy.unizh.ch	Siegrist, M, Gutscher, H. Flooding Risks: A Comparison of Lay People's Perceptions and Expert's Assessments in Switzerland. Risk Analysis 2006, 26/4:971-979.
	Different natural hazards	regional		research	Plapp, Tina	Plattner, Th., Plapp, T. and Hebel, B: Integrating public risk perception into formal natural hazard risk assessment Nat. Hazards Earth Syst. Sci., 6, 471-483, 2006
	Different natural hazards	regional		research	Plattner, Th.	Plattner, Th.: Modelling public risk evaluation of natural hazards: a conceptual approach. Nat. Hazards Earth Syst. Sci., 5, 357-366, 2005
37 Turkey	Earthquakes	households		research	Seda Kundak; kundak@itu.edu.it	
38 Ukraine						
39 United Kingdom	Flooding	households		empirical research	FHRC (FLOODsite)	
	Flooding	Local, households	Floods in south England	empirical research	Whitmarsh, L.	Whitmarsh, L. Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. Journal of Risk Research 2008, 11/3:351-374.

Country	Natural hazard	Scale: national, regional, local, households	Concrete event?	Research or practice?	Contact Details	Remark and Literature
	Flooding	Households, regional		research	JOINT DEFRA	Twigger-Ross, C: Managing the social aspects of flooding: a synthesis report. R&D Technical Report SC40033/SR6
	Flooding			empirical research	N. Pidgeon 1998	Pidgeon, Nick (1998): Risk assessment, risk values and the social science programme: why we do need risk perception research. Reliability Engineering and System Safety 59, 5–15.
Cross-Cultural	Flooding	Local/international		empirical research		http://www.crue-eranet.net/partner_area/documents/Final_Report_PRO_Floodplain.pdf