

# Risk aversion

The term and the phenomena  
related to complex risk issues

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related to complex risk issues

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# 1. Introduction

## 1.1 Background

In 1995 the Swiss Federal Office for Civil Protection (FOCP) published a report (known as KATANOS) on catastrophes and emergencies in Switzerland. In this report the total risks for all natural, technological and societal risks were quantitatively determined. A risk aversion factor was applied, by which single large-scale consequences weighed more heavily than smaller consequences distributed over longer time spans. As a result, the relative significance of different hazard events changed, and earthquakes emerged as the greatest risk for Swiss society.

After the publication of the KATANOS study the concept of risk aversion was discussed in a number of fora. Among these was the Swiss National Platform for Natural Disasters (PLANAT), which in 1999 commissioned a pilot study to provide an overview of current knowledge regarding the phenomenon of risk aversion, and to give recommendations for further work.

The pilot study demonstrated that risk aversion can be viewed from a number of different scientific perspectives. Recommendations for further work in the area were presented. These recommendations were discussed at a workshop in Zurich 18-19 December 2000 as part of an ongoing cooperation between the Swiss FOCP and the Swedish Rescue Services Agency (SRSA).

Since the workshop in Zurich the SRSA has formed a working group of researchers and practitioners to pursue the issue of risk aversion. Within this framework the department of Leadership and Management at the Swedish National Defence College was commissioned to review the state of the art regarding risk aversion, both as a concept and as a phenomenon, from a behavioural science perspective. This work is reported here.

## 1.2 Structure of the report

This report takes as its starting point the Swiss pilot study, which is briefly presented and discussed in the next chapter, (chapter 2).

The following chapter (3) examines the term risk aversion and its use in scientific literature, focusing mainly on the diversity of definitions and applications between and within different fields.

Chapter 4 approaches the phenomenon of risk aversion from the perspective of behavioural science research on reactions to risks and losses regarding societal hazards and major accidents. A brief overview of some more recent empirical and theoretical developments is presented.

In the fifth chapter the issue of introducing a risk aversion factor in societal decision-making is discussed within the broader context of current debate on the role of public risk perceptions.

The sixth and final chapter presents some conclusions and suggestions for further research.

## 2. Discussion of the first Swiss report

This section presents a brief overview of the main findings and ideas from the Swiss report: D. Vischer (2000) *Assessment of natural hazards: dealing with catastrophic events (risk aversion)*.<sup>1</sup> Some critical aspects are then discussed in the context of the present work.

### 2.1 Overview and main findings

The purpose of the Swiss report was i) to provide an overview of current knowledge regarding the concept of risk aversion and experiences of its application in risk models and ii) to identify gaps in this knowledge and to suggest further work in the area as a basis for a main study.

#### A definition of risk aversion

The definition of risk aversion used in the study is taken from the glossary of PLANAT as follows: *Risks arising from infrequent events with large consequences are assessed differently from risks occurring with the same statistical expected value but as a sum of many smaller events: an accident claiming ten victims is judged as more serious than ten accidents each claiming one victim. If someone assesses a risk as greater than its statistical expected value would indicate, then this can be termed risk aversion.*

#### Why a risk aversion factor?

Three arguments in favour of explicitly introducing a risk aversion factor into societal risk decisions are presented:

- Explicit rules facilitate a uniform way of dealing with catastrophic risks and demonstrate the intention to incorporate social risk perceptions into decisions
- Explicit rules increase public trust in authorities in the event of a catastrophic event occurring, and may to some extent protect against extreme reactions under such circumstances
- Explicit rules lead to more attention being paid to the increasing degree of catastrophic potential in society, which might otherwise easily be repressed from daily awareness.

#### Four perspectives

The report then provides a brief outline of four perspectives on risk aversion, each representing a different theoretical and disciplinary approach.

The first is decision theory, emanating primarily from mathematical game and utility theories. From this perspective risk aversion is viewed as a deviation from calculated functions of maximum utility.

The second perspective is that of the natural sciences and deals with the impact of various events on a closed system with limited capacity for regeneration. Models are presented which

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<sup>1</sup> The original report was in German, and a Swedish translation was also made of some parts. The comments here are based on these two sources. We wish to alert the reader to the possibility of some confusion of terminology or possible misinterpretations in the progression from German to Swedish to English!



indicate that the impact of catastrophic events is greater and requires longer time for recovery than the collective impact of many minor events. From this perspective the introduction of a risk aversion factor in models of system equilibrium is necessary to adjust the expected degree of damage and time required for recovery.

The third perspective is that of behavioural science. Here risk aversion is discussed as a characteristic of human perception of risk. At an individual level risk aversion can be related to psychometric studies of risk, i.e. the results of Slovic and others showing that people perceive greater risk from hazards characterized by high ratings on a number of subjective dimensions, including the possibility of many immediate fatalities. These dimensions can be summarized in the two factors *dread* and *unknown risk*. At the societal level *the social amplification of risk model* places risk aversion in a context of attenuating and accentuating mechanisms in society (media, lobby organisations, etc).

The fourth approach is pragmatic and considers practical applications of risk aversion. A distinction is made between explicit and implicit approaches, which can be quantitative or qualitative. Some examples of such explicit practical applications include railway tunnels, avalanches, railway crossings and tunnels (Swiss examples). Implicit examples can be found in F/N curves in which acceptability is indicated in such a way as to require a lower relative probability for high consequence events. Extremely high safety requirements in certain fields, eg air transport and nuclear energy, are given as examples of qualitative approaches. These may not be explicitly expressed, but may instead be an intrinsic part of the processing of various issues.

#### Conclusions and recommendations

The report concludes that:

- ❑ There is at present no accepted definition of the concept of risk aversion in general, or of risk aversion regarding major disasters /catastrophes in particular.
- ❑ There is a lack of understanding of the significance of risk aversion regarding catastrophes (and of the need to consider this in risk and safety analyses)
- ❑ There are hardly any principles formulated as to the formal application and quantification of risk aversion

The report recommends that the following be undertaken:

- ❑ A systematic analysis, from a multi-disciplinary perspective, of the particular characteristics of catastrophic events
- ❑ Study and evaluation of concrete examples regarding the influence of risk aversion on risk assessments and decisions
- ❑ Establishing an arena for decision-makers and stakeholders to, on the basis of the above analyses and examples, discuss principles and possible solutions.

## 2.2 Comments to the Swiss report

The focus of the Swiss pilot study is on natural hazards. The report states that risk aversion has previously mainly been discussed in the context of technological risks, and provides arguments as to why the phenomenon should be given greater consideration also within the framework of natural hazards. Current debate in the field indicates that the distinction between natural and man-made hazards is becoming increasingly blurred and difficult to maintain. There is a growing awareness of the complex interrelationships between human interventions and natural phenomena in the developing risk panorama. The point that risk aversion is discussed in application to some sources of risk more than to others is however one topic, which deserves further investigation. In this report some psychological and social mechanisms related to this are discussed.

The arguments presented in favour of explicitly introducing a risk aversion factor are interesting. However, the theoretical and empirical basis for these is not self-evident and needs to be analysed further. (For example, under what circumstances is it true that public trust in authorities is strengthened by such rules, if an event actually does occur? Should there be concern that introducing explicit risk aversion principles might be viewed as “pandering to public opinion” or “an insurance for the reputation of authorities if anything goes wrong”, and if so what consequences would this imply?). Arguments *against* introducing a risk aversion factor also need to be examined and evaluated. This theme is discussed further in this report.

The Swiss report presents a behavioural science perspective based mainly on Krimsky & Golding (1992). This source provides a brief overview of the major theoretical contributions of behavioural science theory up until the beginning of the 1990s. Research development over the last ten years has seen an increased focus on the role of values and emotions in risk perception and assessment, also on the issue of how social science models can be integrated into societal risk management processes. Some of these more recent developments are outlined in sections 4 and 5.

### 3. Risk aversion: the term and its use in different fields

#### 3.1 Data base search

In this section the use of the term "risk aversion" in different scientific areas and applications is examined. Examples of some different ways in which the term has been applied are provided in order to illustrate the context dependency of different senses in which the term has been used. The purpose here has been to illustrate the considerable variation found, but no attempt has been made to provide a complete overview of the entire area. In view of the considerable amount of literature found related to this term, such a complete overview would in itself constitute a major research project.

A literature search was conducted in 20 data bases during the period October 2001 to April 2002 in order to give an overview of the use of the term "risk aversion" within some different subject areas. The results from the literature searches are presented in Table 1 below.

**Table 1. The literature searches concerning "risk aversion" in data bases of Cambridge Scientific Abstracts from 2001 and 2002 respectively.**

<i>Search strategy</i>	<i>Data base</i>	<i>Date</i>	<i>Number of records</i>
Risk aversion	Aquatic Pollution and Environmental Quality	October 31, 2001	4
Risk aversion	<u>AgeLine</u>	November 1, 2001	14
Risk aversion	ASSIA: Applied Social Sciences Index and Abstracts	November 1, 2001	21
Risk aversion	ATLA Religion Database	November 1, 2001	1
Risk aversion	BHI: British Humanities Index	November 1, 2001	5
Risk aversion	<u>EconLit</u>	November 1, 2001	250
Risk aversion	e-psyche	November 1, 2001	22
Risk aversion	ERIC	November 1, 2001	9
Risk aversion	<u>PAIS International</u>	November 1, 2001	2
Risk aversion	PsycINFO (1984 – 2002, April week 2)	April 26, 2002	143
Risk aversion	PsycINFO (1984 – 2001, October week 2)	November 1, 2001	135

Risk aversion	PsycINFO (1967 - 1983)	November 1, 2001	15
Risk aversion	PsycINFO (1872 – 1966)	November 1, 2001	0
Risk aversion	Social Services Abstracts	November 1, 2001	8
Risk aversion	Sociological Abstracts	November 1, 2001	18
Risk aversion	Environmental Engineering Abstracts	October 31, 2001	5
Risk aversion	Health and Safety Science Abstracts	October 31, 2001	16
Risk aversion	Pollution Abstracts	October 31, 2001	20
Risk aversion	Recent References Related to Your Search	October 31, 2001	1
Risk aversion	<u>Risk Abstracts</u>	October 31, 2001	166
Risk aversion	Water Resources Abstracts	October, 31, 2001	39
Risk aversion	Web Resources Related to the Social Sciences/Humanities	November 1, 2001	1
Risk aversion	Web Resources Related to Your Search	October 31, 2001	3

The data bases searched in 2001 cover Aquatic sciences (1), Environmental sciences (5) and Social sciences (13) besides the services Recent References Related to Your Search and Web Resources Related to Your Search.

In sum searches based on the search strategy "risk aversion" yielded 620 records in October and November 2001. This gives an idea of the number of hits found for this term on one search occasion per data base.

The increase in use of the term "risk aversion" over time can be illustrated in PsycINFO, the data base with the longest time span (from 1872 and forward to the present day). A search in PsycINFO for 1872 – 1966 gave no hits; 1967 – 1983: 15 hits; 1984 – 2001 week 2: 135 hits. A search in the same base in April 26, 2002 gave 143 hits.

The term "risk aversion" is not included in the thesaurus for PsycINFO. The earliest hit for the term in this data base is an article in the Harvard Business Review from 1967 (Hammond, 1967). (During 1967 the terms "cognitive processes" and "decision making" were included as subject categories in PsycINFO). The subject matter of the article concerns the use of preference theory in order to improve decision tree analysis; the preference curves of decision makers are classified as "risk averse", "neutral" or "risk prone". Thus in its original use, the term "risk aversion" appears to have been used to denote an attitude towards "risk", and was

operationalized as a preference curve derived from a laboratory study on decision making in an economic context.

Even at this basic level of analysis it is clear that the term is relatively recent, being found in a psychological context from 1967 and on. The frequency of use of the term has increased markedly during the past 20 years. The use of the term has also spread to data bases covering quite different areas of specialization than PsychINFO.

## 3.2 Risk aversion – a term with several meanings

### Examples from some different subject fields

The purpose of this part of the report is to exemplify the variation in the way the term “risk aversion” is used.

The following method has been adopted to produce examples of different ways to apply the term ”risk aversion” and to analyse these examples. The examples were selected in two steps. First 25% of the hits obtained from literature searches regarding ”risk aversion” in all data bases were randomly sampled. A qualitative sampling strategy was applied to these 25% with the purpose of achieving a maximal variation in the meaning of the term ”risk aversion”; different variations were documented and significant common patterns were identified (Miles & Huberman, 1994).

This 25 % procedure was not applied to the data base EconLit (250 hits). Instead, the economic literature was represented by articles with economic content from journals included in the other data bases. This strategy was applied for the purpose of obtaining a greater spread of the ways of application of “risk aversion” from relatively fewer reports in relation to different academic disciplines.

Analysis of the selected examples was conducted to stepwise identify differing dimensions of meaning and application for the term “risk aversion”.

### Results – Description of examples of different main categories and subcategories concerning the meaning of “risk aversion”

In the following, 8 main categories are presented in order to demonstrate the heterogeneity of the term risk aversion. The subcategories of the first main category are described in order to underpin the existence of different nuances even within one and the same main category. See table 2 for an overview.

**Table 2. Overview of the examples of different applications of the term “risk aversion” presented in this report.**

<i>Main categories</i>	<i>Subcategories</i>
1. “Risk aversion” as derived from utility theory	“Risk aversion” with implicit assumptions of relations to underlying latent variables
	“Risk aversion” dependent on time horizon
2. “Risk aversion” – a judgement riskier than that which corresponds to the statistical expected value	
3. “Risk aversion” as personal avoidance of uncertainty	
4. “Risk aversion” – an aversion against uncertainty based on experience	“Risk aversion” as a motive for maintaining one kind of inter-individual relation
5. “Societal risk-aversion” as a social construction	“The risk-averse society” with intentions to risk elimination
	“Risk aversion” as a post modern strategy
6. “Risk aversion” as a cognitive style	
7. “Risk aversion” as dependent on affect, emotion and motivation	“Risk aversion” as influenced by framing
8. “Risk aversion” as an observed higher prevalence of risks	

1. *“Risk aversion” as derived from utility theory.* The first main category of the exemplified uses of “risk aversion” contains a description, derived from utility theory, of the shape of a decision or cost-benefit function, and a prediction from this function of how it will influence the individuals economic decision making (usually portfolio choice problems, lotteries or insurances). In this category there are no explicit assumptions and analyses of relations between “risk aversion” and psychological and social variables. (See note 1 for examples of reports included in this main category).

In this first main category the following subcategories among others are to be found:

- a) “Risk aversion” with implicit assumptions of relations to underlying latent variables. – In some of the reports belonging to this main category there are, however, more or less implicit assumptions that the shape of the cost-benefit or decision

function called “risk aversion” is related to underlying latent variables such as some sort of general disposition. In an example taken from an insurance context (Natvig & Gåsemeyr, 1981), this disposition is assumed to make frequent minor losses preferable to rare major losses if the person can choose between two risks with these respective qualities, which both have identical expected annual claims expenses. This same report finds also obvious similarities between risks with frequent minor or rare major losses and society’s choice of hydroelectric, fossil or nuclear power. In analogy with the former example the authors state that two energy supply alternatives giving the same expected annual loss do not have to be assessed as equally risky. But in the case of the energy supply problem, the risk associated with nuclear power is underestimated if only expected annual loss is considered. The risk aversion in this case is linked to the possible catastrophic nuclear power accidents.

The authors also assert that the probabilities of different types and degrees of damage associated with energy production are not known exactly for those who calculate the risks. The possibility of incorrectly estimating the damage probability enters with e.g. a new, insufficiently known reactor type, as an extraordinary contribution to the risk. And these authors by pointing out: “It is not irrational to be risk averse when confronted with great uncertainties.” (Natvig & Gåsemeyr, 1996, p. 189).

Another example in this subcategory says that risk preference, i.e. also risk aversion, to be sure is partly a question about individual disposition, but may also, as a reaction, have some “rational causes” (Turner, 2000). The author gives as an instance the case where low-income workers are more risk averse when choosing portfolios than more well paid workers, i.e. they tend to invest in low risk, low-expected-return shares when the individual is responsible for managing the investment of the funds. Such reactions may partly depend on a lack of knowledge in financial issues.

b) “Risk aversion” dependent on time horizon. – In a report within the second subcategory the authors contend that risk attitude, i.e. risk aversion and risk tolerance, depend on time, at least concerning investments. More specifically, the authors’ interpretation of data showing that cultural and environmental factors affect risk attitude is that *career time horizon* is the factor that plays the major role in shaping the approach to risk issues. (Jaggia & Thosar, 2000). As an example, younger managers are more willing to choose the riskier alternative simply because they intuitively realise that they have plenty of time left in their professional careers to start something new if things should go wrong. The authors suggest a change of the utility function as a consequence of their interpretation of the importance of the career time horizon for investments (Jaggia & Thosar, 2000).

2. In the second main category the term risk aversion is defined as judgement of a situation as riskier than that which corresponds to the statistical expected value of damages as consequences of natural accidents (PLANAT, 2000) (See chapter 2 above for a discussion.)
3. “Risk aversion” as personal avoidance of uncertainty. In this third main category “risk aversion” is also derived explicitly from utility theory. In addition to the standard assumptions of utility theory some relationships between utility and quality are introduced. This is exemplified in a model of consumer response to contamination uncertainty (Foster & Just, 1988). Here risk aversion involves a welfare loss because of

uncertainty concerning health risks. Different types of imperfections in information can affect this uncertainty. If consumption of a good is continued because information about the contamination is withheld, then the individual may sustain psychological costs such as worry about the extreme effects of contamination retrospectively. If information is limited, or there are exaggerated reports in news media, then individuals may also experience consumer fright, with the consequences of unnecessary avoidance costs (Foster & Just, 1988).

a) A subcategory in this context, but with a less explicit relation to utility theory, could be represented by a report focusing on some wider implications of the effects of fishing on marine ecosystems (Dayton et al., 1995). This report advocates cautiousness in the exploitation of marine ecosystems. This attitude is motivated by scientific knowledge about the resource systems in question. According to this report, one kind of measure to take is by means of restrictions on the fishing industry to try to avoid risks that researchers on marine ecosystems notice indications of. However, a number of social processes prevent these indications from being taken seriously. Among other things, the authors discuss the scientific bias towards eliminating Type I errors and its compounding with the legal tradition in which the burden of proof is placed on the regulator. The authors consider a risk aversive attitude to be the only defensible one in this case (Dayton et al., 1995).

4. “Risk aversion” is an aversion against uncertainty based on experience. – In this fourth main category risk aversion is used as a term for a reaction of affected people to avoid risks and failures from conditions they assess as negative or uncertain with reference to their own experience, knowledge, tradition, etc. Thus, here risk aversion is an aversion against uncertainty or against accepting uncertain situations.  
An example here is a report about the indigenous farmers’ reactions concerning the water supply of a large-scale irrigation project in Nigeria. Risk aversion in this example meant that these farmers tried to cope with the perceived insufficient or highly uncertain water supply. Their assessment of the irrigation project was made in the light of their experiences, tradition and knowledge about local conditions (Kolawole, 1989) (cf. Stage & Rekve, 1998).

a) A subcategory in this context treats “risk aversion” as a motive. In this example, risk aversion is viewed as a possible reason for maintaining one kind of inter-individual relation, in this case opposite-sex friendships as platonic, because of fear or worry about being disappointed or hurt in another type of relation (Messman, Canary & Hause, 2000).

5. “Societal risk aversion” is socially construed. – The fifth main category of meaning of “risk aversion” implies that individuals or groups of individuals often develop a perception of risks from technological hazards that is more extreme than the risk perception coming from technical risk assessment (e.g. Yardley, Wright, & Pearman, 1997).

The report taken as an instance of this main category does not presume that an accident has to happen in order to evoke a societal risk aversion (Yardley, Wright, & Pearman, 1997). The basis of “societal risk aversion” is risk perception at an individual or group level, which is affected by qualitative features of risk-related phenomena, media coverage, bias in judgements, and trust. Other components in risk aversion are social



and cultural factors, e.g. interests, values, etc. (Cf. Social Amplification Theory described in a chapter 4). The report taken as an example focuses the distinction between societal risk perceptions and technical risk assessment (Yardley, Wright, & Pearman, 1997).

a) A subcategory here is “the risk-averse society” (Barnes, Perkinson & Talbott, 1998). This term implies that risk-aversion is influencing society, the economic world, and politics with the intention of trying to eliminate risks; e.g. ban on smoking in public places, prohibited sale of tobacco to juveniles, a law prescribing seat belts and how to use them. “Risk aversion” is here a culture philosophical “realist-viewpoint” term on a societal level – between technological determinism and social or cultural constructivism.

b) A second subcategory in the context of the impact of computers on culture is Talbott’s idea of “risk aversion” as a postmodern strategy. He discusses the arguments of Perkinson, who argues that society has become more risk-averse in part as a result of computerization. As computers increasingly compile statistics which are widely broadcast to all, our consciousness about risks is raised. Within scientific disciplines “scholars eventually had to be satisfied with abstruse, mathematical models that didn’t relate to much of anything they had previously cared about, or else they had to resort to an epistemological relativism that made their own views impregnable (...) before the computational onslaught. This last tactic, employed by postmodernism, is born of risk aversion. One tries to become safe from attack – immune to the precise certainties of computer modelings” (Barnes, Perkinson & Talbott, 1998, p. 10). According to Talbott a more fundamental category than risk aversion is needed to understand what is happening and that category is “meaning”. He argues that people who are driven by “meaning” are not risk-averse (Barnes, Perkinson & Talbott, 1998).

6. “Risk aversion” as a cognitive style – The sixth main category builds on the idea that there may be systematic deviations from an expected value decision process that may be determined by the individual’s cognitive style. In that context risk aversion and risk seeking may be considered as cognitive styles that affect the individual’s decision making in risk issues.

One of the purposes of the study that exemplifies this category was to examine whether there are individual differences in the use of cognitive heuristics and risk-assessment decision modes (Shaham, Singer, & Schaeffer, 1992). One result was that a high internal consistency was observed in the risk seeking and risk-aversion scales, suggesting that consistent individual differences across situations might exist in these decision modes but not in the representativeness and availability heuristics. A conclusion from this study was that risk-seeking and risk aversion can be conceptualised as cognitive styles that affect individual’s decision making regarding risk.

7. “Risk aversion” as dependent on affect, emotion and motivation. – The seventh category represents an assumption of relations between affect, emotion, motivation and risk taking.

A laboratory study in which positive affect was manipulated in three experiments is an instance of this category. The authors concluded that the induction of positive affect did not necessarily increase the willingness to spend, instead positive-affect subjects indicated that losses seemed more aversive to them compared to control subjects. In consideration of a meaningful loss, subjects in a positive mood should be more risk-averse than control subjects if they risk suffering a loss sufficient to ruin the happy state they are experiencing. The authors continue to say that research in this field should focus on the role that affect plays in increasing avoidance of meaningful loss (Arkes, Tandy Herren, & Isen, 1988).

a) “Risk aversion” (and risk proneness) as influenced by framing. –A report that investigated the influence of framing on risk-taking can be an example of this subcategory. The authors (Highhouse & Yüce, 1996) asserted that the terms *threat* and *opportunity* refer to individual perceptions, while Kahneman & Tversky’s (1978) “loss” and “gain” refer to decision-making perspectives. Consequently they concluded that threats and opportunities could be perceived in both gain and loss domains, which was supported by the experiment results (Highhouse & Yüce, 1996).

8. “Risk aversion” as higher prevalence of risks. – In this main category risk aversion means just an actual observation of higher prevalence of different risks regarding individuals and groups.

An example here is a study of the distribution of health risk factors among race and ethnic groups (Hahn, Vesely & Chang, 2000). The authors defined health risk aversion as a behaviour pattern that resulted in few or no risk factors and health risk proneness as a pattern of many risk factors. These definitions did not intend to suggest the intentional avoidance or seeking of health risks, but meant only the de facto observation of higher prevalence of lower and higher numbers of health risks than expected by population distributions of the risks in question.

### 3.3 Comments

As stated above, the intention of this section has not been to present a complete analysis of the meaning or the appearance of this term in the current sample of Cambridge Scientific Abstracts. Nevertheless, from the examples above of different meanings and ways of application of “risk aversion”, it is clear that this term does not have a homogeneous meaning.

In the first three categories the meaning of “risk aversion” is more or less directly derived from utility theory and a utility function, with no explicit assumptions or more elaborated analyses of relations to psychological and social variables. The other 5 main categories make assumptions of various types of social and other variables, giving different meanings to “risk aversion”.

This exemplified heterogeneity of “risk aversion” would seem to dilute the term and render it somewhat less interesting. However, these different meanings attached to the term “risk aversion” do relate to a number of different phenomena which are of considerable interest in examining the broader issue of how people perceive and react to risks. In the remaining parts of this report these phenomena are focused.

## 4. Major hazards/catastrophes: a behavioural science perspective

In the previous chapter the term “risk aversion” was the starting point. In this and the following chapter the perspective is changed to consider the phenomena related to human responses to major hazards and catastrophes.

The Swiss report presented several arguments related to the possible positive effects of introducing a risk aversion factor, as defined in that report, in societal decisions. It is suggested that such measures could lead to:

- a more uniform management of catastrophic risks
- an increased focus on low probability - high consequence events
- increased public trust in societal risk management
- less extreme societal reactions in the event of a catastrophe

Clearly the proposed effects are based on various assumptions concerning individual and collective perceptions, attitudes, values and actions. The purpose of this section is to present a brief overview of some more recent empirical and theoretical developments in behavioural science research on risk perception and reactions to major hazards which could be relevant to these assumptions.

### Literature sources

The field of behavioural science research on risk is vast, even though its history spans only about four decades (Renn, 1998). In recent years a number of collected works covering seminal articles in the field have been published, for example Slovic, 2000; Flynn, Slovic & Kunreuther, 2001; Cvetkovich & Löffstedt, 1999; Jaeger, Renn, Rosa & Webler, 2001; Löffstedt & Frewer, 1998. The aim here has not been to reproduce well-known findings in the field, but rather to focus on central issues which support or question the above arguments.

The literature on which this overview is based is derived from three main sources:

i) Collected overviews of main areas of behavioural science research, such as those cited above.

ii) A literature search carried out in the data bases PsycINFO (from 1984 on), Sociological Abstracts, Risk Abstracts, Health and Safety Abstracts based on the following terms:

Risk perception

Risk combined with feeling\*

(Accident\*, hazard\*, disaster\*, catastrophe\* risk\* ) combined with (perception, attitude\*, emotion\*, fear, anxiety, aversion), also combined with (public, societal)

iii) A search of the contents index and article abstracts in the following journals for the periods indicated:

Health Risk and Society (1999 - 2002)

Risk Analysis (1995 - 2002)

Reliability Engineering and System Safety (1995 - 2002)

## 4.1 Perception of catastrophic risk

One suggested effect of introducing an explicit risk aversion factor is to promote a more uniform management of catastrophic risks. Perhaps the most striking result of forty years of risk perception research is to demonstrate the *lack of uniformity* in perception of risk. Factors related to the source and consequences of the risk itself, to the context in which it is assessed and to the individual assessor all influence how a risk is perceived. This section outlines some work related to these differences.

The issue of whether management of catastrophic risks *should* be uniform, and thus to some degree be geared towards avoiding the influence of differences in risk perception, is discussed further in chapter 5.

### Risk perception and the psychometric paradigm

Since the 1970s the psychometric paradigm has dominated much of the research on human perception of risk (see Slovic 2000 for an overview of this work). According to this paradigm risk is subjectively defined by individuals on the basis of influences from a wide array of psychological, social, institutional and cultural factors. Thus perception of risk is affected not only by probability and estimates of fatalities, but is sensitive also to factors such as perceived voluntariness, scientific knowledge about the risk, controllability and potential threat to future generations.

In the early work these factors were grouped into two main dimensions, reflecting the degree to which the risk from a particular hazard is *understood* and the degree to which the risk evokes a feeling of *dread*. Perceptions of risk were closely related to the position of a hazard on these two dimensions. Assessing that a risk has potentially catastrophic consequences forms a part of the *dread* dimension.

The psychometric model has strongly influenced our view of how risks are perceived, but has been and remains also the subject of animated debate. One issue concerns the explanatory power of the original dimensions, and the need to include also other significant factors or dimensions in order to explain variation in perception of different risks. Sjöberg (2000) has for example presented evidence that the perception of “tampering with nature” contributes significantly to perception of risk. Risks are perceived as greater if they are judged to be “unnatural”, a finding which has been linked to moral and ethical evaluations.

The consequences of a possible event influence risk perception, and in particular demand for risk reduction. How important people consider it to be that authorities deal with a certain risk is determined more by the perceived consequences than by the perceived likelihood of an event occurring (Sjöberg, 1999). Slovic (2000) argues that this focus on consequences is hardly surprising, since the consequences of a major event are far more difficult to predict or assess than the likelihood. Thus expert calculations of consequence often focus on fatalities and material damage, while ignoring the long-term social and psychological effects of a major accident. According to this line of reasoning, lay people do take into account also such less tangible consequences in their assessments of risk and demand for risk reduction.

The consistent pattern of results presented by the psychometric approach has been based on aggregate data and mean values and can perhaps best be viewed as a mapping of the general “personality” of different risks. Psychometric studies have generally been conducted using

standard survey methodology. The results reflect how people rate abstract risks on scales defined by terms such as "voluntary - involuntary", "known to science - ", etc. The relative importance of different qualitative dimensions has, however, been shown to vary considerably for judgements of different hazards (Gardner & Gould, 1989). Thus for example the dimension "catastrophic potential" was found to be important for nuclear and chemical technologies, but less so for risks related to air or road travel. Closer analyses which have been based on individual rating data have also demonstrated considerable variation between individuals in their assessments. Trumbo (1996) for example categorized individuals as risk "amplifiers" or "attenuators" according to the position of their judgements along the dread and knowledge dimensions.

Interpretation of the psychometric model has become more complex in the light of research highlighting new factors and sources of variation. Clearly it cannot be simplistically viewed as a model of deeply held values which can be applied straight off to real life problems in specific contexts. As Slovic (2001) has pointed out, this has never been the aim of the psychometric work. Later work linking the psychometric model to research on emotional reactions (see section 4.2) does however seem to indicate that *dread*, related to lack of control and *knowledge*, related to uncertainty, do capture two fundamental aspects of how risks are perceived.

#### Individual and group differences

Lack of uniformity in perception of risk is manifested in the considerable literature on individual and group differences. Attempts to explain why people differ in their perceptions of risk have particularly focused on gender and on socio-cultural factors.

An early line of research in this field has been concerned with cultural theory and the relation of risk perception to socio-political groups. Although the theoretical underpinning of this approach has a strong intuitive appeal, empirically it has proved less satisfactory as a model to explain variations in risk perception (Sjöberg, 2000). One criticism concerns the validity of the four or five main socio-political groups identified by cultural theory, particularly outside the United States. Another has concerned the idea that socio-political group can explain the variation in perception over a wide range of risks, for which the evidence is at present slight.

Another line of research has focused on differences attributable to gender and to socio-cultural factors, and to the linking of these two (Flynn et al., 1994). This latter line of research has identified a subgroup within the white male group who demonstrate extremely low risk perceptions in comparison with other groups. This group also differs markedly from others in a number of attitudes and beliefs, being for example more trusting of technological hazards, and more negative to the role of government in risk management. These results, termed "the White Male Effect", have been discussed in terms of differences in perceived trust, control and power over technology. More recent work (Finucane et al., 2000) gives further support to this white male effect, but also demonstrates that the distinction between this group and others is more complex than originally thought. Whether corresponding subgroups can be identified in cultures other than the United States is open to question.

## Contextual factors

Risk issues are perceived and evaluated within a specific context. The simple wording and presentation of a risk problem can influence how this context is perceived, as Amos Tversky & Daniel Kahneman demonstrated in their early work (e.g. Tversky & Kahneman, 1981). This phenomenon, known as “framing”, can influence the decisions people make depending upon which aspects of the problem are highlighted.

The discussion of framing as a phenomenon has later been broadened from the laboratory setting to decision-making about environmental, technological and other public health risks. Vaughan & Seifert (1992) demonstrate how the framing of risk problems in public debate can intensify conflicts, pointing in particular to three significant dimensions in how risk problems can be conceptualised. The first concerns which individuals are highlighted as being at risk. Messages about risk are likely to elicit very different responses depending on the characteristics of the individuals emphasized as primarily “at risk”. Demonstrating that children are at risk is for example likely to elicit strong responses. The second dimension concerns how the focus on potential gains versus losses is presented. This is a direct application of the prospect theory findings that losses have a greater psychological impact than comparable gains, where decision-makers will be more risk-seeking in avoiding certain losses than in maximising gains. Opinions can be manipulated by reframing problems in terms of losses or gains, as also by the manner in which the starting or reference point from which assessments are made is formulated. A third dimension concerns the use of economic or scientific frames, contra frames reflecting equity and considerations of fairness or justice. Conflicts related to siting of toxic or nuclear waste plants have in many instances developed from confrontations between scientifically based frames (evaluation of the risk involved) and fairness or equity frames (social effects, compensation, public participation).

To sum up, in the light of more recent research perception of catastrophic risk has emerged as a more complex phenomenon than might be indicated by earlier models. Among the factors of significance appear to be: characteristics of the risk other than catastrophic potential, socio-cultural factors and values, and not least the context in which the risk is framed.

## 4.2 Risk aversion and decision making

One effect of framing in real-life problems may be to minimize the focus on possible catastrophic risk. Analyses of the decisions leading up to the Hallandsås tunnel scandal (a toxic contamination of ground water occurring in connection with the construction of a tunnel through a hill in southern Sweden) demonstrate how the decisions to be taken were framed in contexts of economic and technical development, while systematically neglecting issues of risk (see supplements to the commission report SOU 1998). It would be interesting here to examine more closely the suggestion in the Swiss report that an explicit risk aversion factor might increase the focus on low-probability/high consequence events – presumably meaning among decision makers.

Societal risk aversion is usually discussed as a layman phenomenon. In a French study Hubert et al. (1991) demonstrated that decision-makers were strongly “adverse to catastrophic accidents” in expressing attitudes toward industrial risk. 30 decision makers in the community of Lyon responded to questions regarding the importance of different incentives for controlling major hazards, and gave quantitative evaluations related to aversion to catastrophic accidents. Interestingly, elected representatives put more weight on the incentive

concerning "worry about living under the threat of an accident" than did other categories of decision makers.

The reasoning behind the decision-makers aversion to catastrophic accidents was not examined further in this study. In discussing attitudes related to the siting of a nuclear waste depository, Sjöberg & Drottz-Sjöberg (2001) suggest that perceived social acceptability may be one factor behind risk averse responses in relation to real risk problems, thus "*tolerance may be seen as a reflection of egotistic cynicism while risk aversion could signal true concern about the well-being of others*". A related concept is that of accountability, a concept which takes into account an important fact - that people do not think and act in a social vacuum (Lerner & Tetlock, 1999). Perceived accountability has been shown to influence the risk decisions people make. For example in experimental situations, knowing that one can be held accountable (and will have to explain one's decision to others) tends to make risk-averse people more risk avoiding.

Emphasis on accountability has been suggested as an argument in promoting risk awareness among decisions makers. In an analysis of the events and decisions occurring prior to several major catastrophes, including the Piper Alpha oilrig explosion, the capsizing of the Herald of Free Enterprise ferry, and the NASA Challenger disaster, Hopkins (1999) points to two reasons why organisations often fail to devote resources to minimising risk of disasters. One reason lies in the apparent irrationality of decisions taken, often demonstrating a pattern of systematic denial of risk aspects within the organisations responsible. Hopkins uses the term "institutional irrationality". Another reason may lie in the weakness of the popular argument that "safety pays", at least for the organisations concerned. In fact, Hopkins argues that catastrophes sometimes actually provide economic benefit for the organisations involved, at least in the longer term. If economic loss is a less tenable motivation for managers to develop their safety measures, Hopkins proposes that a stronger focus should be made on the emotional and social price to be paid in the event of an accident. In other words, the incentive might be that safety pays primarily in emotional terms.

Surprisingly little research has focused on the perceptions and rationale behind the actions of decision makers, at least within a real-life context of social risk management. This is an important area to explore further.

### 4.3 Risk and emotions

Risk perception research has developed primarily within a cognitive framework. However, increasing interest in the role of emotions in perception and assessment of risk can be noted during recent years. Larrick (1993) for example criticizes cognitive and economic approaches such as prospect theory and expected utility theory on two counts. Firstly, they tend not to consider the possibility that people might have affective responses to risk itself. Secondly, they assume that basic psychological mechanisms governing judgments of risk and value are common to all people, while offering little explanation for individual differences. Larrick summarizes some findings within the framework of motivational theories of decision making indicating the role played by such feelings as failure, regret and disappointment. He argues that empirical evidence suggests that people focus on two goals when they make decisions. "One goal is to maximize their expected outcomes; the other goal is to maintain a positive self-image". Thus anticipation of how one might feel about the consequences of a decision is one of the outcomes taken into account.

The emotional “content” of a decision can also affect risk choices. In a series of elegant experiments Rottenstreich & Hsee (2001) demonstrate that the affective reactions associated with the potential outcomes of a risky choice affect the S-shaped weighting function described by prospect theory, increasing the S-shape. People are more sensitive to departures from impossibility and certainty but less sensitive to intermediate probability variations for affect-rich outcomes, either positive (such as kisses from film stars!) or negative (electric shocks). The explanation forwarded for the larger jumps at the endpoints of the function is in terms of emotional reactions. The difference between knowing that an outcome is impossible and knowing that there is some slight chance of its occurrence is greater for emotionally relevant choices. These affective reactions related to the endpoints of the function are hypothetically labelled *hope* and *fear*. Thus risk as feeling tends to overweight frightening consequences.

Purchasing insurance is not simply an issue of monetary compensation. Hsee & Kunreuther (2000) have demonstrated that people are more willing to purchase insurance, and more willing to go to trouble in claiming insurance, the more affection they feel for the object in question (keeping the economic benefit constant). Again, the emotional value of the outcome significantly affects the choices made. The stronger desire for compensation after a valued loss is interpreted in terms of “consolation” for pain and emotional distress experienced.

Thus emotions related to the consequences and to the subject matter of a decision appear to influence the weights accorded to different outcomes. Emotions can also directly affect risk perception. It has been demonstrated both under natural conditions and experimentally induced that fearful people express pessimistic risk estimates and risk-averse choices, while angry people express optimistic risk estimates and risk-seeking choices (Lerner & Keltner, 2001). Interestingly, these studies have been designed to demonstrate that it is not primarily the valence of the emotion (positive or negative), but rather the appraisal tendencies underlying these emotions which affect judgments. Thus the emotions fear and anger differ markedly in the appraisal themes of certainty and control. Fear is characterized by low sense of certainty and of personal control, while anger is related to high certainty and control appraisals. As a result of these differences fear and anger activate sharply contrasting perceptions of risk.

Certainty and control bear a clear resemblance to the dimensions “unknown” (cf uncertain) and “dread” (cf uncontrollable) identified as influencing risk perceptions in the psychometric paradigm. Thus it can be hypothesized that feelings of uncertainty and lack of control significantly influence risk perception and can be related both to the individual personally and to the type of risk involved.

Another line of research seeks to map the various different emotions arising in relation to different characteristics of risk issues. Thus Böhm (2002) identifies three different emotional dimensions in relation to perception of environmental risks. One concerns loss-related emotions, such as fear and worry. The other dimension reflects morality-based emotions, such as anger, outrage and guilt. A third dimension is related to feelings of helplessness. The main focus in Böhm’s study (2002) concerns how the activation of these different emotional dimensions is related to issues such as whether the risk is perceived as natural or not, or attributions of responsibility.

One conception of the relation between affect and risk judgements is that of an “affective pool” containing all the positive and negative images we associate with the phenomenon to be



assessed. Finucane et al (2000) propose that people when judging risk issues use an "affect heuristic" summoned from this experientially developed pool. This idea is something of a parallel to the cognitive heuristics, such as availability, vividness etc, described by Tversky & Kahneman (1981).

The possible strengths and weaknesses of such affect heuristics linked to risk judgements have as yet only begun to be explored. New light has been shed on the role of emotions in judgement through the work of neuroscientists such as Damasio (1994), who have demonstrated that logical argument and analytic reasoning cannot be effective unless guided by emotion and affect.

Damasio argues that thought is made largely from images - a life-time of learning leads these images to become "marked" by positive and negative feelings linked directly or indirectly to somatic or bodily states. When a negative "somatic marker" is linked to an image of a future outcome, it sounds an alarm. This lends neurophysiological support to the idea proposed early by Zajonc (1980) that affective reactions could precede cognitive appraisals. The work of Damasio and others indicates that somatic markers increase the accuracy and efficiency of the decision process and the absence of such markers, observed in people with certain types of brain damage, degrades decision performance.

Thus the long-held view that deliberative and non-emotional assessment of alternatives is the optimal model for all human decision making is being reconsidered in the light of current research in a number of fields. It would appear that rational decision making requires proper integration of both modes of thought.

Recent work on decision making in real life settings is highly relevant to this discussion, and a brief outline of some current ideas is given in Appendix 1.

## 4.4 Risk aversion and the social context

The Swiss report suggests that introducing a risk aversion factor in societal decisions could i) increase public trust in societal risk management and ii) lead to less extreme societal reactions in the event of a catastrophe.

### Public trust

The role of trust in the context of various issues concerned with risk perception and management is a research topic that has attracted considerable interest during the last decade. The whole issue of trust is a complex one, and in this context only a few points relevant to the risk aversion discussion will be briefly considered. These points are mainly taken from a recent doctoral thesis (Viklund, 2002), which provides a useful overview of some of the main issues, and also questions some of the assumptions previously made regarding the role of trust.

A number of studies have shown that trust is a multidimensional concept. One focus of psychological research has concerned the determinants of trust, identifying components such as competence, openness, fairness, credibility and care/empathy. The role of trust in relation to risk perception is under some debate. There is some agreement that trust plays a more

important role when the level of knowledge is low. When people feel they know little about a risk themselves, then trust in experts becomes more important.

It seems unlikely that the introduction of a risk aversion factor per se can be expected to increase public trust in societal risk management. The issue of public trust also raises moral and ethical questions concerning societal risk management. In a European perspective the Trustnet programme (Dubreuil et al., 2002) provides some insights as to how these issues can be tackled in societal risk governance. Current debate regarding public trust and public participation in risk-related decision-making is discussed further in chapter 5.

### Reactions to major risk events

How people react to the occurrence of a major accident is clearly not simply related to the number of fatalities or extent of the damage. Some events with few or no fatalities can still give rise to strong emotional reactions because of the significance people attach to them. Usually the majority of people are not affected directly by the event itself, but react to reports or images of the event. Strong visual images convey not only information but also powerful symbolic messages (Boholm, 1998). There is however little knowledge as yet as to the emotional and social effects in a society where more and more such images are communicated to the public.<sup>2</sup>

The *social amplification framework* proposed by Kasperson et al. (1988) suggests that peoples' reactions are shaped by the interaction between aspects of risk events and psychological, social, institutional and cultural processes in society. Thus as hazard events (actual or hypothesized) are communicated in society they are filtered through various social and individual "amplification stations", such as the media, government and other agencies, stakeholder groups etc. Such filtering can lead to *attenuation* or *amplification* of an issue, and to secondary or "ripple" effects which can go far beyond the initial impact of the event. Within the social amplification framework the perception that an event provides new information about the likelihood of similar or more destructive future mishaps (e.g. the Three Mile Island nuclear power plant in 1977, the Challenger shuttle disaster 1986) can lead to the amplification of reactions to that event.

The idea that a risk aversion factor could lead to less societal reaction (less amplification and/or ripple effects) after a hazard event needs to be considered within a general framework such as that provided by the social amplification theory. To date there is little empirical evidence to support this idea. It has been suggested that several factors may need to be present in combination in order for an issue to "take off" (Kasperson, cited in Pigeon, 1998). Again, it is not self-evident that attenuated societal reactions necessarily are desirable under all circumstances.

## 4.5 Comments

In this section we discussed empirical and theoretical research on how people react to major accidents, disasters and catastrophes (both as risk scenarios and as actual events). Empirical evidence suggests that aversion in relation to societal accident and disaster risks (as opposed to economical risks) is a far more complex phenomenon than is captured in the classic expected utility / prospect theory laboratory work. There is support for the view that certain

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<sup>2</sup> Writing this particular section on the 11<sup>th</sup> September 2002 brings this question into sharp focus.

types of events do have a relatively greater psychological and social impact than others, although the characteristics of such events are more complex than are summed up in the "ten killed in one event, or one killed at each of ten events" definition.

There is little support in behavioural science research that the introduction of a risk aversion factor in risk management decisions will per se have the effects proposed in the Swiss report. The complex pattern of factors affecting reactions to risks and trust in management procedures indicate that such a measure needs to be viewed in a context which takes into account the groups affected, the type of risk and the context of the decision.

## 5. Risk aversion and societal risk management

Introducing a risk aversion factor into societal risk decisions could be motivated for several different reasons. One such reason could be that the risk of events with catastrophic consequences is in fact increasing, to a greater extent than is reflected in conventional risk analyses. Researchers such as Beck (1992) and Perrow (1984) have for example argued that the potential for such major accidents is increasing as a consequence of socio-technical developments in society. A further reason that has been forwarded is that the effects of catastrophic events, when they do occur, are multiplicative as regards the physical and social damage caused. A third and less tangible motivation for introducing such a factor is that humans are naturally risk averse, thus such decisions would best reflect societal values (the previous chapter examined some of the assumptions related to this latter motivation).

Given that certain risks do have disproportionately severe implications, the question is then if and how this could or should be taken into account in societal decision-making (Pigeon 1998). This section discusses some of the angles from which this issue has been approached and some of the arguments forwarded.

### 5.1 Unequal evaluation of lives saved

Whipple (in Krimsky & Golding, 1992, s 347-8) reports an anecdote from a workshop held in 1981 by the Nuclear Regulatory Commission (NRC) to discuss quantitative safety goals for nuclear power plants. A method for weighting severe accidents was suggested, by which consequences were raised to a power greater than 1 before multiplication by probability. There was support for this inclusion of a risk aversion factor until the social scientist Paul Slovic pointed out that, given equivalent regulatory resources, this proposal would lead to higher expected losses than would a pure expected values approach. The workshop then returned to favouring a risk-neutral approach.

Whipple notes the irony that here engineers on the NRC staff attempted an approach reflecting public values, which was rejected by a group with a strong representation of social scientists strongly committed to including public values in risk regulation policies. The crux of the question is described in terms of framing of the issue:

*“When framed as a simple question of whether it was better or not to include risk aversion, the consensus was for risk aversion. When the question was reframed as “are you for risk aversion if it means that, over the long run, more people may die?” the group’s response was “no” (Whipple, 1992).*

The example provides a good illustration of the influence of framing of risk issues. In this case the group was not prepared to advocate a decision when it was made explicit that this would in fact increase the total number of expected losses. However, a number of studies have presented evidence indicating that in the real world the marginal expenditure to save a statistical life in fact varies greatly between different life-saving interventions. One implication of the disparities in life-saving investments is that a re-allocation of these resources could result in more lives saved, or in the same number of lives saved but at a lower cost. However, this would not take any account of the conception that qualitative

characteristics of the regulated risk and the target population affect the utility of a given intervention.

The implications of these respective arguments have recently been outlined and discussed by Ramsberg (2002). Ramsberg discusses the possible arguments (from the perspective of a "neutral" citizenry acting on the basis of collective preferences independent of the individual's personal circumstances) for or against a departure from equalization of marginal lifesaving investments on the basis of the following aspects:

- Whether ability to pay should count
- Equity and fairness considerations
- Longevity versus lives saved
- A special value for children
- Special value for productive life years
- A premium for preventing involuntary risks
- Special value for catastrophe prevention
- Special value for identified lives

On the basis of his analysis, Ramsberg argues that some of these considerations do warrant a departure from equalization of life valuation. Thus arguments can be made for considerations such as longevity, quality of life, productivity, individual risk equity (fairness) and informed consent in risk taking. He notes that the arguments regarding catastrophic potential and identifiable lives raise complex issues regarding community and social capital that deserve further consideration. Particular social values may be threatened by mass loss of life from a catastrophic event, as also by a society in which no special effort is warranted to save a particular identifiable life.

People evaluate different deaths differently. Sunstein (1997) argues the case for heeding public concern about "bad" forms of death in four particular instances: regarding deaths accompanied by unusual pain and suffering, deaths concentrated among socially disadvantaged groups, deaths involving especially high costs of risk avoidance, and deaths producing unusually high externalities. This latter criterion concerns deaths which generate widespread losses, including those stemming from empathy and fear, and can be expressed in terms of the socially perceived "meaning" of a particular death. In her analysis Sunstein makes the point that "it is important to examine not simply what deaths people especially abhor, but also *why* those deaths are abhorrent, and whether the underlying reasons can survive scrutiny".

An example of such an attempt at gaining a better understanding of the psychological underpinning of attitudes towards saving lives can be found in a detailed study of the identifiable victim effect (Jenni & Loewenstein, 1997). The greater empathic response to the plight of identifiable victims was found primarily to be attributable to the effect of the relative size of the reference group. The greater the proportion of an identified reference group that a measure is perceived to save, the more people tend to support this measure. An identified individual is perceived as constituting his or her own reference group, thus a successful measure taken on behalf of the identified victim will be perceived as a "100 % success". The converse of this effect is when a great number of possible victims are identified as the

reference group, and the measures taken can only save a small percentage of this group (although a large number in absolute terms). Decisions taken under such circumstances tend to be characterized by a phenomenon which has been termed “psychophysical numbing”, manifest as a lack of sensitivity to the value of human life when the number at risk is very great (Fetherstonhaugh et al, 1998). This phenomenon suggests that we are psychologically less able to deal rationally with interventions aimed at mitigating situations of catastrophic risk such as famines or war.

## 5.2 Public perceptions and societal risk management

Thus one issue regarding incorporating reactions to risk characteristics and at-risk populations in societal decision-making concerns the justification of unequal valuation of lives saved. In a wider context this issue concerns the legitimate role of public perception in the management of societal risk. While this issue has been under discussion for at least two decades, the debate has intensified during recent years and the justification of heeding public risk perceptions has come to be increasingly questioned. According to Renn (1998), there are at least three reasons for this more negative view. Firstly, resources for risk reduction have become more scarce under current tight budget conditions. Secondly, satisfying public concerns has proved more difficult than was at first anticipated. Thus, more sophisticated social science research has revealed considerable complexity in identifying relevant subjective risk dimensions, cultural differences and values (see chapter 4 in this report). As a third reason Renn proposes that public opposition to technologies and risk-related activities has been less pronounced during recent years, citing examples in particular from Germany.

**Table 3. Arguments against and in favour of incorporating public risk perceptions into policy decision making**

<i>Arguments against</i>	<i>Arguments in favour</i>
1. Public perceptions are noise / bias	1. Perceptions have consequences
2. The public is not homogeneous in its risk perceptions	2. Experts can be biased too
3. Managing risk merely entails managing public risk perceptions	3. People should have input into risk decisions that affect them
4. Public attitudes are prejudiced / discriminatory	4. Public risk perceptions should enrich expert risk analyses
5. Public perceptions are social constructions – thus unstable and context-dependent	5. Perceptions reflect basic values

Source: Pidgeon and Beattie 1997, revised by Pidgeon 1998

Table 3 summarizes some basic arguments against and in favour of taking account of public risk perceptions in decision making (Pidgeon & Beattie 1997, Pidgeon 1998). The tone of the debate has sharpened, as is reflected in a number of articles in a special issue of the journal *Reliability and Safety Engineering* (number 59, 1998). The arguments underlying fundamentally differing positions will be outlined here on the basis of articles in this issue, primarily those of Cross and Renn.

Cross (1998) argues that public risk perceptions are tainted by misinformation and unreliable heuristics, and offer a poor guide for public policymaking. In fact, "public perception kills" if used as a basis for resource allocation. He points first to sources of bias in public risk perception, for example the effects of framing, media reporting and cognitive heuristics such as availability and dissonance. More interestingly he also scrutinizes some of the assumptions underlying the idea that public risk perception reflects underlying public values, and what these values might be. One argument concerns whose values are reflected, Cross argues that these tend to be those of powerful groups and interests, with an implicit upper middle class bias. Cross also examines the values underlying the risk perception factors of dread, voluntariness, catastrophic effect and control. For example, concern regarding catastrophic effect tends to be centered on technological risks, which raises the question whether it is catastrophes (many victims) or technology as such that is the prime source of concern. While his analysis is provocatively critical, Cross does point to issues which need to be examined further concerning the values which are reflected in risk perception factors.

Another pertinent question concerns whether the public actually *wishes* policy to be based on such perceptions, i.e. "*citizens might logically have a certain set of risk perceptions but not necessarily wish for government automatically to embrace their perceptions*" Sjöberg (1999b). Comparing answers to the question "who should decide on the siting of a high-level nuclear waste repository?" from nuclear waste experts, local politicians and the public, Sjöberg (1999b) found that while the public was more in favour of national referendum and decisions by the people in the local municipality, they were also more positive (28 %) to allowing experts in the nuclear industry to decide than were these experts themselves (11.6 %). In fact, the public were more keen to leave the decisions to the experts than the experts themselves. Clearly it would be interesting to know more about the reasoning behind such wishes. Knowledge of the public view of how risks should be managed is a further area for future work.

Renn (1998) points to the inherently dual nature of risk as a basis for his discussion of the role of public perception in risk management. Risks, he says, are always mental representations of threats, but these threats are also capable of claiming real losses (Renn defines risk as the possibility that human actions or events lead to consequences that have an impact on what humans value). Risk management becomes a matter of integrating these two sides. The real issue is not whether public perceptions should be included, but rather how they should be assessed and integrated into the risk management process so that this reflects people's perceptions, but also competence efficiency and fair burden sharing. Public values need to be assessed in context and within a framework of dialogue and mutual learning. Renn points to three areas where public perception is of significance: in the selection of criteria on which to judge acceptability or tolerability, in determining trade-offs between criteria, and in designing resilient strategies for coping with remaining uncertainties.

A somewhat different line of argument is taken by Starr (2001), who discusses how society might deal with hypothetical public fears related to risks which lack any empirical base on

which to base analyses of probability and or consequences. He takes as examples such issues as global warming, genetic modification and low-level radiation. The gist of his argument is that such fears may be unfounded and yet may influence risk decisions in a non-transparent and potentially unrealistic way with long-term consequences. Viewed from a historical perspective of similar issues, a gradual process of trial-and-error can be traced leading slowly and at some cost to a publicly accepted risk balance. Starr advocates a more direct approach in which fears are regarded as mental concepts which can be defined and quantified. The social cost of reducing such fears can be calculated and its feasibility examined.

## 5.3 Risk characterization

One suggestion in the Swiss report concerns establishing an arena for decision-makers and stakeholders to discuss principles and possible solutions regarding risk assessments and decisions. How such an arena might be developed has been a particular focus of interest in more recent social science research. Perhaps the currently most influential model for integrating scientific and social concerns in societal risk decision making is that presented in the USA by the National Research Council (Stern & Fineberg, 1996). The model describes an analytic-deliberative process and is underpinned by the concept of *risk characterization*, which is seen as something far more than simply a summary of scientific information.

Four main facets of risk characterization are that it should i) be decision-driven, ii) recognize all significant concerns, iii) reflect both analysis and deliberation, with appropriate input from the interested and affected parties, and iv) be appropriate to the decision. The approach advocates a balanced synthesis between scientific data and social concerns and suggests how such a process can be implemented. The model can be summed up in five criteria for evaluating the success of the approach:

*Getting the science right*: judging the technical adequacy of the risk-analytic effort

*Getting the right science*: are relevant concerns addressed by the scientific work?

*Getting the right participation*: are all interested and affected parties involved?

*Getting the participation right*: opportunities for parties to contribute?

*Developing accurate, balanced and informative synthesis*: ensuring understanding and lack of bias

Clearly the challenges in meeting these criteria will differ according to the kind of decisions to be made. While advocating caution in categorising different types of decisions the NRC report does suggest five categories within the “risk decision landscape”:

- *Unique, wide-impact decisions*: ie. onetime decisions of national or even wider import
- *Routine, narrow-impact decisions*: eg building design approvals, permits, etc
- *Repeated wide-impact*: eg siting and operating permits for power plants, toxic waste
- *Generic hazard and dose-response characterizations*: inputs for a class of decisions rather than for one particular decision (eg establishing health risks, impacts of climate change, etc)
- *Decisions about policies for risk analysis*: procedural or methodological, which models on which to base toxicological analyses, etc.



Appropriate models for societal risk governance need to be assessed in relation to the context of the problem. A similar approach is advocated in the lessons outlined by the European TRUSTNET programme (Dubreuil et al., 2002). Here the advantages and disadvantages of “Top-Down” and “Mutual Trust” approaches in different contexts are recognized and discussed. The contexts considered can be historical, cultural and political and are related to the nature of the hazardous activity. A dynamic progression between the two approaches is outlined in response to societal expectations and needs, in terms of for example social cohesion and social trust.

## 6. Conclusions and suggestions for further research

Risk aversion can be viewed from a number of perspectives. The original Swiss report pointed out that there is at present no accepted definition of the concept of risk aversion in general. The results of the data base search presented here indicate that the term is increasingly being used and applied in many different contexts and meanings. Many applications do bear some relation to utility theory, or denote some form of aversion or unwillingness to encounter losses or uncertainty. However, uses range from description of the shape of a decision function to characterizing of a post-modern strategy in society as a whole. A further data base search would no doubt yield a number of further meanings and applications.

Defining risk is notoriously difficult, so it is perhaps hardly surprising that defining risk aversion is no easier. Being aware of different meanings and contexts is however important as a basis for a multi-disciplinary approach to the specific issue of risk aversion as related to major disasters/ catastrophes.

The main purpose of this report has not been to dissect the term risk aversion further, but rather to examine from a behavioural science viewpoint the basic idea that “people tend to be risk avert” as related to major disasters / catastrophes. Even a brief overview of more recent research in the field indicates that this is an idea requiring considerable qualification, thus it is more true to say that “some people sometimes tend to be avert to some risks in some contexts”. This more complex picture does not detract from the possible importance of considering a risk aversion factor in dealing with potential disasters, but indicates that the effects of introducing such a factor need to be examined more closely.

Several possible positive effects of introducing a risk aversion factor were suggested in the original Swiss report. Some are related to the risk management process itself, for example in promoting a more uniform management of catastrophic risk and increasing the focus on low-probability-high consequence events. Other effects pertain more to public reactions, including increased public trust in societal management of risks and less extreme reactions if an event should occur. The assumptions about human perceptions and actions underlying these proposed effects have been examined critically here in the light of research findings. On this basis, we find little to indicate that the introduction of an explicit risk aversion factor is likely to lead to the suggested effects, at least not as an isolated measure. Other or complementary ways of achieving these effects need to be examined, as indeed also the value-base and motivations behind setting these effects as goals. It is for example possible that a risk aversion

factor might contribute to a more uniform management of catastrophic risks, but clearly perception of risks is anything but uniform, either between different risks or between different individuals and groups. Furthering the uniform management of catastrophic risks needs to be coupled with methods of dealing with non-uniformity of perceptions and values. Similarly, the justification of setting goals of increasing public trust and reducing societal reactions in the event of a catastrophe need to be examined. Increased public trust should be based on realistic assessments, as opposed to illusions. Concern about societal reactions, coupled to a sense of accountability, may be a strong motivating factor for decision makers to maintain safety considerations.

A change of paradigm from a traditional approach of dealing with threats was briefly mentioned as one factor behind the PLANAT interest in risk aversion. This observation points towards the importance of developing future work on risk aversion within a framework of changing societal approaches towards dealing with risk (cf discussions of concepts such as sustainability, resilience).

Some of the areas we find particularly interesting here for future research are the following:

- Public values with regard to societal risk management. While public perceptions of risk have been extensively studied, considerably less is known about the public values and view of issues underlying management of risks in society.
- Perspectives of decision makers. Far more work has been devoted to the values and perceptions of risk of the public than to those of decision-makers making real-life risk-related decisions. Analyses of some major disaster events have tended to reveal lack of risk aversion in these groups as a major problem (the Swedish case of Hallandsåsen provides a good example). An important area for study is to identify the conditions necessary to promote and maintain risk awareness in these groups.
- Development of an arena for decision makers and stakeholders. An examination of the applicability of the NRC model (briefly described in section 5.3) for decisions regarding possible major disasters / catastrophes in a European context could be a starting point for developing the type of arena suggested.
- Case studies of actual decision problems to analyse the possible effects of introducing risk aversion considerations from a multi-disciplinary perspective. With an analogy to the thinking applied in newer research on bounded rationality regarding decision making in real life settings (see Appendix 1) it could be worth while to explore the possibilities to create a valid and step-by-step diagnosis instrument, “a toolbox”, for risk-related situations of different scope.

# Notes

The following reports are included as examples in category 1 (see p. 10):

1. The theory of risk aversion. <http://cepa.newschool.edu/het/essays/uncert/statepref.htm>
2. Natvig & Gåsemyr (1996)
3. Pesquin et al. (1999)
4. Davies (1981)
5. Yamada (1990)
6. Landskroner et al. (1990)
7. Röell (1987)
8. Müller (2001)
9. Thorlund-Petersen (2001)
10. Jaggia & Thosar (2000)
11. Chillemi (1988)
12. Roth (1983)
13. Sahin (1980)
14. Feder & O'Mara (1981)
15. Need & de Jong (2000)
16. Turner (2000)

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# Decision making in real life settings

As indicated in section 3 in this report, “risk aversion” was originally a term for a risk attitude in decision-making (see e.g. Hammond, 1967).

The discussions about the term “risk aversion”, which resulted in the start of this project, made it clear that the interest in this term referred primarily to real life contexts. “Risk aversion” was in these discussions related to reactions, judgements and decisions in connection with natural hazards. Also for that reason it may be relevant to here describe something of the ongoing scientific debate regarding decision making in real life settings in connection to “risk aversion”.

In the area of decision-making, an increasingly animated debate has been in progress during the last 15 years concerning e.g. decision-making studies in real life situations, naturalistic decision-making and dynamic decision-making in contrast to so-called traditional decision research in laboratory settings. In addition, research about decision-making and judgement has appeared during recent years that increasingly questions the assumptions of rationality which form the basis of traditional decision research (Gigerenzer, 1996, 2000a, 2000b; Gigerenzer & Selten, 2001; Gigerenzer et al., 1999; Todd, 2001).

Traditional decision research has tended to focus on only one component of the decision-making, namely the decision event. In this approach the most important part of the decision making occurs when the decision maker (usually an individual) examines a known and fixed number of decision alternatives, considers what the probable consequences might be if one or the other alternative is chosen and finally chooses one of them. That is to say, the decision maker judges here the possible alternatives in terms of a number of objectives, aims or values, which are stable over time and known by her or him. The study of decision events tends to focus on how decision makers collect accessible information in their choices of a best alternative (see e.g. Kleindorfer et al., 1993; Orasanu & Connolly, 1993).

An alternative way to view decision-making is Brehmer’s (1990) approach to the study of dynamic decision-making. Here the study of decision-making is done in a dynamic, real time context. Consequently it is made part of the study of action, rather than the study of choice. The problem of decision making, as seen in this framework, is a matter of directing and maintaining the continuous flow of behaviour towards some set of goals rather than as a set of discrete episodes involving choice dilemmas.

In a real-life context, judgement and decision-making are part of a continuous process and are not themselves the principal aim and goal of the activity (Brehmer, 1990; Gigerenzer et al., 1999; Jungermann, 1983; Klein et al., 1993). Among other things, preferences will develop over time and be shaped by experiences. Accordingly, it is important to get information about cognitive representations of problems, such as framing, also in post decisional processes as for example implementing of decisions (Jungermann, 1983).

Here decision making in real life situations means decision making outside laboratory settings in a continuous social context.

## Some characteristics of decision making in real life settings

Orasanu and Connolly (1993) mention the following significant factors that characterise decision making in naturalistic settings: ill-structured problems; uncertain dynamic environments; shifting, ill-defined, or competing goals; action loops and feedback loops; time stress, high stakes, multiple players and organisational goals and norms.

In the contexts characterising real life decision situations the decision problems generally do not appear as clearly defined as they do in decision situations in a laboratory setting. In real life situations the decision makers have to activate themselves in order, for example, to hypothesize what will happen and determine what could be relevant decision and action alternatives. A fire ground commander's decision situation when dealing with a fire (Klein et al, 1986) is an example where observable situation factors may be related to each other by complex causal connections, interactions between causes, feedback loops, etc.

Decisions in real life situations take place most often in uncertain, dynamic contexts. That is, the settings could change rapidly within the time limits of the decision required. What was a small fire some minutes ago could now be a major blaze. Decision-making in "real life" also occurs in situations with incomplete or unreliable information. The decision maker may have information about a part of the problem, e.g. the rescue service units available or the costs for developing a product, but has no information about other parts of the decision problem, e.g. how far the fire has spread or of the probable size of the market for the product. The information could also have various meanings or may be invalid. Thus observers could be uncertain about what they see, and a diagnostic method may not cover all possible illnesses that a certain symptom could represent. The validity of the information may be questionable if it comes from an intelligent opponent, e.g. information warfare or misleading information as a mean of competition between companies (Orasanu & Connolly, 1993).

As mentioned above, in real life settings a decision maker usually has the intention to attain broader goals than just to make a decision, as the decision is only a part of a longer chain of activities. Outside the laboratory it is unusual for a decision to be dominated by one single clearly understood goal or value. Instead, decision makers usually have many aims in these contexts (e.g. save lives, maintain health, preserve property, etc.). Conflict and trade-offs between different purposes and goals are particularly difficult in real life situations because the issues are often new and have to be settled rapidly.

Characteristically, real life problems tend to trigger a chain of action over time in order to deal with them. Thus action and feedback loops are here of frequent occurrence, for example in finding out more about the problems. Awareness of this fact requires an approach to decision-making quite different from the idea of focusing on one discrete decision event.

In many real life contexts decisions are made under considerable time pressure, which has several consequences. Decision-makers often work under high stress. Under strong time pressure decision-makers tend to make use of less complicated strategies of reasoning and decision-making.

Decision-making in real life contexts may also raise stress levels when the decisions involve high stakes. The scenarios in question include those where the consequences have great interest for the people involved (e.g. rescuing lives, maintaining health or preserving property for a rescue service corps; keeping an enterprise in a region; saving lives in an intensive care unit; saving the future of an entire company, etc).

In many real life decisions there may be many persons in different roles involved in the decision making process, rather than one single decision-maker. An example can be taken from the local decision process in Sweden. A local authority chief officer said that: "You know, a tremendous amount of the actual control after all is about different superiors' and colleagues' way of handling the current activities, which is rather far from ...but is leading towards the political decisions. There is an everyday work situation where nevertheless lots of, surely hundreds of, detail decisions are made without being registered anywhere..." (Lajksjö, 1998).

A decision can also be distributed among persons who partly co-operate and partly compete, persons who should co-ordinate their functions but do not in reality do this. The contribution of different departments to decisions on risk and safety issues in local authorities in Sweden can serve as an example in this context. Since there are usually a number of different purposes and goals in real life decision-making settings, difficulties may arise in the process if all persons involved do not share the same understanding of the meaning and goal of the situation.

Decision making in real life settings often takes place in an organisational context. Such a context has relevance for the decision making process in two ways. Firstly, values and goals that are applied and will direct the decision-making do not depend only upon the personal preferences of the involved individuals. There are also "global" or organisational values and goals, which will influence the decision making strongly. Secondly, organisations can respond to different difficulties of decision-makers by creating more general goals, rules and standard procedures for dealing with these issues. Such factors are difficult to introduce into artificial settings such as laboratories.

## Rationality in judgement and decision making in a real life context

According to Gigerenzer (2000) and Gigerenzer et al. (1999), the majority of models for rational decision-making in social and behavioural sciences, in cognitive science and economics, are based on some form of the doctrine that the decision maker should have complete knowledge or mental representation of the decision environment. He or she goes through all available information and considers all possible decision alternatives, weighing the consequences of each of these and using optimization calculations to make decisions based on this knowledge.

As outlined above, recent decision research, on the contrary, (see e.g. Gigerenzer, 2000b; Gigerenzer et al., 1999, Gigerenzer & Zeltner, 2001) has focused actual judgement, decision-making and dealing with an uncertain environment by people in real life settings. Results from this type of research program have shown that human beings in such contexts behave according to heuristic or bounded rationality models, i.e. decision making methods that use

very little information, calculations and analyses of alternatives to make a number of different decisions. The term “bounded rationality” emanates from the conviction that a theory of human rationality has to consider the actual cognitive capacities of human beings, among other things the limitations in knowledge, attention and memory. That is, this vision of rationality does not make an assumption of optimisation as the process of decision making, in contrast to the assumptions underlying traditional decision research (Simon, 1956). In the right environment, however, bounded rationality models can lead to optimal or good-enough results. Gigerenzer (2000a) calls attention to the fact that optimisation does not guarantee optimal outcomes; for example, some of the simplifying assumptions, which optimisation in the complex real world requires, may be false.

For models of bounded rationality there is an adaptive toolbox of situation-specific heuristic methods that work in certain situations, but would be useless in others. This expression of “adaptive toolbox” is actually a Darwinian metaphor for decision-making in real life, i.e. ecological, settings. The heuristics in the toolbox are domain specific, not general, just as evolution does not follow any “grand plan”. It simply results in many different solutions for specific problems (Gigerenzer, 2000a). Also, the heuristic decision methods in the adaptive toolbox are not rational or irrational per se. They are only relative to a certain environment, in the same manner as adaptations are context-bound.

Results from research on real life decision making show that simple domain specific heuristics can be about as accurate as complex general optimisation strategies that work with many free parameters (Gigerenzer, 2000a; Gigerenzer, 2000b; Gigerenzer et al., 1999). One explanation is that these domain specific heuristic methods must not be too specific, but have to be able to be generalised to and used in new situations. This is the meaning of the concept “robustness”. In an uncertain situation only a part of the information that is obtainable today will be of a predictive value for the future. Making good decisions or predictions under uncertainty requires that one must ignore much of the information available. The crucial thing is to find those elements that can be generalised (Gigerenzer, 2000a; Gigerenzer et al., 1999). It should be noted that there is an important difference between “fitting” of a strategy, i.e. to fit a decision-making method or strategy to a given set of data and generalisation (Gigerenzer, 2000a; Gigerenzer et al., 1999). In fitting, which is a common application of optimisation strategies, it is usually true that the more parameters a model has, and the more information or cues it uses, the better it will fit given data (Gigerenzer et al., 1999).

“Risk aversion” and the phenomena and processes often concealed beneath this term are very much concerned with judgement and decision-making, mainly in real life settings. The view of decision making that is gradually emerging from more recent results of decision making research, particularly the vision of bounded rationality, clearly appear relevant to consider also in this context.

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