

# RISK PERCEPTION AND RISK MANAGEMENT: A REVIEW

## Part 1: Risk Perception

**Ortwin Renn**

Center for Environment, Technology, and Development, Clark University, Worcester, MA, 01610, USA.

**Abstract:** While experts confine the term risk to a combination of magnitude and probability of adverse effects, lay persons associate with risk a variety of criteria, such as voluntariness, possibility of personal control, familiarity, and others. To improve our knowledge about the risk perception process is crucial for improving risk management and risk communication. Responsive and rational approaches to risk management should recognize the results of risk perception studies in two ways: First, management has to address the concerns of the affected public and find policy options that reflect these concerns; second, risk reduction or mitigation should be tailored towards the goal of meeting not only the risk minimization objective, but also the implicit criteria of risk characteristics that matter to the public. If these criteria are in conflict with each other, tradeoffs have to be made and justified through legitimate instruments of conflict resolution. Risk perception studies can help to identify public concerns and shape the arena for conflict resolution. In addition, risk perception studies offer valuable insights for designing and implementing risk communication programs.

## INTRODUCTION

Since the 1950s psychologists have investigated the intuitive mechanisms of people to collect, assimilate, and evaluate information about activities or technologies with uncertain outcomes (Edwards 1954; Coombs and Pruitt 1960; Slovic et al. 1979; Slovic 1987; a review in Covello 1983 and Renn 1986). The major objective of these studies has been to explain the psychological relevance of probabilistic information for the formation and change of attitudes and corresponding behavior. The interest in public perception was fueled by the observation of an often pronounced difference between the views of decision makers and sections of the public regarding the seriousness of certain risks and the desired balance between risks and benefits for certain hazards (Otway and von Winterfeldt 1982).

The term "risk perception" can easily lead to the impression that the public has a common and all-encompassing rationale for assessing and evaluating risks. In reality, however, people perceive technologies or events and not an abstract concept such as risk. In addition, the components of risk perception depend on the type of risk source under consideration and

differ between various segments of the population. It is thus misleading to use the term risk perception for describing a single public response to risk sources. Rather risk perception denotes a variety of concepts and mechanisms to process probabilistic information depending on the risk context and the individual (Renn 1985 and 1989). In some contexts, risk refers to the thrill and excitement of undertaking a difficult challenge, such as mountain climbing or rescuing a person from a burning house. In another context, risk is perceived as a chance to achieve a possible goal, such as investing in the stock market or participating in a lottery. Large scale technologies, on the other side, evoke associations of continual pending danger. Risks posed by these technologies generate considerable public attention and anxiety because the observer has the impression that the catastrophic event can occur at any time and leaves little time for protective actions. The probability of such an event is usually not considered as a factor in evaluating the seriousness of such a risk, but it is rather the perceived randomness of occurrence and the time span between the accidental release and the resulting health effects that most people use as yardsticks to delineate judgments about the riskiness of a technology or activity.

In addition to social context, risks are also perceived differently depending on the social position, the cultural beliefs, or values of the individual or group involved (Douglas and Wildavsky 1982; Vlek and Stallen 1981). Surveys have clearly demonstrated that persons who feel closely attached to

the values of economic performance and standard of living, perceive technological risks as less threatening than persons who have developed a special sensitivity towards environmental protection and equity issues (Bisconti 1989; Rayner and Cantor 1987). The more people depend economically on the production sector of society the more they feel that risk-taking is an inevitable and ultimately rewarding activity for individuals and society.

In spite of these differences in understanding and processing risk, many studies have shown surprising similarities in the fundamental mechanisms that most people employ to assess the potential risk of an activity or technology and to justify their concern or neglect of such risks (Slovic et al. 1979; Gould et al. 1988; Covello 1983). The following briefly describes such fundamental processes of risk perception which seem to underlie the intuitive assimilation of probabilistic information for large segments of society and surprisingly enough across national and cultural borders.

## **INSIGHTS FROM RISK PERCEPTION STUDIES**

### **The Determinants of Risk Perception**

Starting with the pioneering work by Decision Research in Eugene, Oregon, (Fischhoff et al. 1978; Slovic 1987) psychometric methods have been employed to explore the characteristics of risk that influence the intuitive judgment of seriousness of risk and its acceptability. The following aspects of

risk have been found to affect the perceived riskiness of objects or activities:

**Expected number of fatalities or losses.** Although the perceived average number of fatalities correlates with the perceived riskiness of a technology or activity, the relationship is weak and generally explains less than 20 percent of the variance (Renn and Swaton 1984). The major disagreement between technical risk analysis and risk perception is not on the number of affected persons, but on the importance of this information for judging the seriousness of risk. In several risk perception studies, many respondents expressed fairly accurate predictions on the estimated average losses of life and limb over time for different risk sources (Slovic et al 1980; Renn 1984). High risks were usually underestimated and low risks overestimated, but the overall correspondence between calculated and perceived risks was much better than many risk experts had expected (Lichtenstein et al. 1978). In contrast to the expert community, however, the respondents did not base their evaluation of riskiness on the prediction of fatalities, but relied more heavily on so-called qualitative characteristics, such as dread of potential consequences or perceived quality of institutional control. Communication programs that are geared toward informing the public about the probabilities of rare events are therefore only of limited value, since the perception of riskiness is a function of many different factors of which the results of technical risk assessments is only one among others (Jungermann 1982).

**Catastrophic potential.** Most people show distinctive preferences among risk choices with identical expected values, but variations in the range of outcomes over time (Slovic et al. 1979; Covello 1983; Royal Society 1983). Low-probability high-consequence risks are usually perceived as more threatening than more probable risks with low or medium consequences. If people fear that a major disaster may result from a failure of a technology and if such a failure is not intuitively understood or imaginable as a low probability event, the perceived catastrophic potential impacts then on the perceived seriousness of such a risk (von Winterfeldt et al. 1981). For example, coal-fired power plants are usually perceived as less risky than nuclear power plants since the catastrophic potential of nuclear energy is seen as more dramatic and far-reaching than that of coal energy. Neither the acid rain problem nor the threat of the greenhouse effect have significantly changed that perception (WEC 1989).

**Circumstances of the risk (qualitative characteristics).** Surveys and experiments revealed that perception of risks is influenced by a series of perceived properties of the risk or the risk situation (Fischhoff et al. 1986; Slovic et al. 1982; Renn and Swaton 1984). Among the most influential factors are: dread; personal control; familiarity with risk; the perception of equitable sharing of both benefits and risks; and potential for blame (possibility to make a person or institution responsible for the creation of a risky situation). A more comprehensive list of qualitative risk factors is shown in Table 1.

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**Table 1: Summary of Risk Perception Studies.**

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**Risk Perception is a function of:**

1. intuitive heuristics, such as availability, anchoring, overconfidence, and others
2. perceived average losses over time
3. situational characteristics of the risk or the consequences of the risk event
4. associations with the risk source
5. credibility and trust in risk-handling institutions and agencies
6. media coverage (social amplification of risk-related information)
7. judgment of others (reference groups)
8. personal experiences with risk (familiarity)

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**Risk Perception is influenced by:**

- a) voluntariness
  - b) controllability
  - c) catastrophic potential
  - d) delay of consequences
  - e) tendency to kill rather than to injure
  - f) perceived threat to future generations
  - g) equal exposure to risk
  - h) equal risk-benefit distribution
  - i) familiarity with risk
  - j) perception of benefits
  - k) exclusiveness of benefits
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The degree to which risk invokes a feeling of dread and unavailability is strongly correlated with perceived riskiness (Krewski et al. 1987). With respect to different energy systems, nuclear energy is associated with many negative qualitative factors, such as dread, inequitable risk-benefit distribution, and unfamiliarity; whereas decentralized solar energy mobilizes

mostly positive associations, such as subject to personal control, low catastrophic potential, and equitable distribution of risks and benefits. So it is not surprising that most studies on public perceptions reveal a positive risk perception pattern for solar energy versus a more negative for nuclear energy (Gould et al. 1988; Renn 1984; Otway 1980).

**Beliefs associated with the cause of risk.** The perception of risk is often part of an attitude that a person holds about the cause of the risk, i.e. a technology, human activity, or natural event (Otway 1980). Attitudes encompass a series of beliefs about the nature, consequences, history, and justifiability of a risk cause. Due to the tendency to avoid cognitive dissonance among beliefs, most people are inclined to perceive risks as more serious and threatening if the other beliefs contain negative connotations and vice versa. A person, for example, who believes the use of pesticides is linked to profit-seeking behavior of agro-industrial corporations is more likely to think that the concomitant risks are high than a person who associates pesticides with the global struggle of societies to fight hunger and malnutrition. Risk estimates are therefore constantly adjusted to the overall judgment of the desirability of the technology in question.

**Credibility of the risk management institutions.** Many risks are taken by society without consent of each individual affected and his or her possibility to mitigate the risk through personal actions. Those collective risks are only accepted if the affected population

is confident that the lack of individual control is compensated by institutional control (Gould et al. 1988; Vlek and Stallen 1981). Confidence in risk management institutions relies on perceived competence and trustworthiness (Renn and Levine 1988). The public expects these institutions to have the expertise to monitor and control the risk and to be impartial and independent in their judgments and actions. Attitudes towards nuclear energy in the United States, for example, are closely correlated with the assignment of credibility to the Nuclear Regulatory Commission (Freudenburg and Baxter 1985). The credibility of an institution is largely determined by two factors: the perception of past performance (competence) and the perception of openness and flexibility to incorporate and process new information and public demand (responsive and honest interaction with society). In addition, the public expects institutions to be fair in distributing protective services and to accept the concept of checks and balances (Renn and Levine 1988).

**Distribution of risks and benefits among the affected population.** Equity issues play a major role in risk perception. The more risks are seen as unfair to the exposed population, the more they are judged as severe and unacceptable (Kasperson 1987; Royal Society 1983). It should be noted that the estimation of severity and the judgment about acceptability are closely related in risk perception. The analytical separation in risk estimation, evaluation, and management, as exercised by most technical risk experts, is not paralleled in public perception. Most

people integrate information about the magnitude of the risk, the fairness of the risk situation, and other qualitative factors into their holistic judgment about the (perceived) seriousness of the respective risk. They take equity issues into consideration and evaluate the magnitude of the risk in terms of equal distribution of risks and benefits. This concern for equity has often been labelled as the NIMBY (Not In My Back Yard) syndrome. Although evidence suggests that many people express inconsistent preferences when it comes to nearby or remotely sited facilities, most studies show, however, that the underlying argument is not so much to avoid a risk for oneself and impose it on others (as the NIMBY syndrome would suggest), but to avoid situations in which risks are imposed on one part of the population while another part enjoys the benefits (Marks and von Winterfeldt 1984).

This list of factors demonstrates that public understanding of risk is a multi-dimensional concept and cannot be reduced to the product of probabilities and consequences. Although risk perceptions differ considerably among social and cultural groups, the multi-dimensionality of risk, the importance of qualitative risk factors, and the integration of beliefs (associated with the risk itself, the cause of the risk, and its circumstances) into a consistent belief system appear to be common characteristics of public risk perception among all segments of the population and among different cultures. Risk perception studies have been conducted in most western European countries, the USA, Canada, Australia and some

eastern and developing countries (cf. the citations in Covello 1983; Borchering et al. 1986; Renn 1984 and 1989). All of these studies conclude that similar mechanisms are involved, but that these mechanisms can be compensated, attenuated or amplified by specific social, cultural, or political factors. From the perspective of an individual, the cultural environment co-determines the degree of confidence in one's own judgment of probabilities and riskiness (Wright and Phillips 1980); from the societal perspective, organizational and social preferences for risky choices can be penalized or awarded by cultural stimuli (Hofstede 1980). In spite of these cultural and social differences, risk perception seems to be characterized by a series of apparently universal factors that represent common sense mechanisms for coping with uncertainty (Renn 1989).

## PERCEPTION AND PROCESSING OF PROBABILITIES

In addition to the circumstances and qualitative aspects of risks, the meaning and understanding of probabilities have been the subject of numerous studies (Kahneman and Tversky 1974; Slovic et al. 1979; Vlek and Stallen 1981). Apparently, common sense reasoning is governed by a categorical and deterministic model: either something is safe or unsafe, healthy or unhealthy, acceptable or unacceptable. Such a dichotomous approach obviously simplifies the complexity involved in stochastic events, but it provides a sufficiently accurate mechanism to guide one's own action in everyday life without imposing excessive time require-

ments for routine decisions. The deterministic approach to decision making conflicts, however, with the necessity to set an acceptable risk level for all stochastic risks (risks without threshold of no effect). The question "How safe is safe enough?" poses an abstract choice situation which transcends common experience of most people. This is one of the reasons why standards for stochastic risk reduction are so much in the focus of public controversy about risk management.

Since most people are unfamiliar with stochastic reasoning, they use a variety of simplified cues or heuristics to judge the probability of an event or activity. Among these heuristics are (Kahneman and Tversky 1974; Slovic et al. 1979; Renn 1988):

**Availability:** Events that come to people's mind immediately are rated as more probable than events that are less mentally available. For example, most people can recall at least one or two major nuclear accidents (such as Chernobyl or TMI), but do not recall any dam failure although statistically many more fatalities have been recorded as a result of dam failures than of nuclear accidents.

**Anchoring effect:** Probabilities are adjusted to the information available or the perceived significance of the information. The easier it is to imagine a disaster or another adverse effect the more likely people perceive such an outcome to occur. If people can smell or visually detect a pollutant, the more they feel that such a pollutant is likely to affect their health. Symbolic cues,

such as warning labels or monotonous high pitched music (often used to illustrate the danger of radiation) can serve as substitutes for concrete anchors and often amplify the perception that danger is eminent.

**Representativeness:** Singular events experienced in person or associated with properties of an event are regarded as more typical than information based on frequencies. Someone who experienced an unlikely event, such as witnessing a person struck by lightning, tends to overestimate the likelihood of such an event. Redundant information stemming from an identical source is usually perceived as more reliable than singular, non-redundant information. In each of these cases, inferences are made on the basis of limited or biased observations. A mere list of all unusual events in a chemical factory promotes the impression that technical failures are more common there than in other factory types where occupational safety is less monitored and reported to the public.

**Avoidance of cognitive dissonance:** Information that challenges perceived probabilities that are already part of a belief system will either be ignored or downplayed. Persons who already hold negative attitudes toward a technology or an activity are likely to oppress all information that challenges their prior attitude and seeks information that reinforces their initial position. The avoidance of cognitive dissonance is a powerful filter for selecting and rejecting information and one of the reasons that public information or communication campaigns often have only very

limited effect on attitude change (Renn and Levine 1988).

Because probabilities are vital components of risk perception, risk managers must account for the intuitive preference for deterministic reasoning and the overt biases of processing probabilistic information. Furthermore, the terms used in framing probabilities, for example chance of lives lost versus lives saved, or the probability of dying versus survival, lead to different reactions by the receivers (Dawes 1988). Risk perception studies are therefore vital instruments for designing risk management policies and risk communication programs.

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