# 6 Risk perception and risk communication

This chapter first discusses risk perception, then risk communication.

## 6.1 RISK PERCEPTION

According to SRA (2017b) (refer to items 13 and 14 in Section 3.1.1),

> Risk perception refers to a person's subjective judgement or appraisal of risk, which can involve social, cultural, and psychological factors. Risk perceptions need to be carefully considered and incorporated into risk management, as they will influence how people respond to the risks and subsequent management efforts. Risk perception studies are important for (i) identifying concerns but not necessarily for measuring their potential impacts and (ii) for providing value judgement with respect to unavoidable trade-offs in the case of conflicting values or objectives.

The risk field builds on a huge literature on risk perception and related behavioral decision-making research. This literature constitutes an important basis for the science of risk analysis. The risk perception research has identified a set of biases (heuristics) in people's ability to draw conclusions from probabilistic formulations and information (see e.g. Tversky and Kahneman 1974, Rohrmann and Renn 2000, Renn 2008). The risk perception research has also revealed different meanings of risk, depending on the context in which the term is used (see e.g. Slovic 1987, Renn 2008). People's understanding of risk extends beyond the professional characterizations based on consequences (loss) and probabilities. These characterizations provide a too narrow perspective on risk, as important risk-related aspects for

the decision-making, such as affect, controllability and familiarity, are not considered. Closely related to this conclusion is the well-known dichotomy between the two modes of thought: *System 1*, which operates automatically and quickly, instinctively and emotionally, and *System 2*, which is slower, more logical and deliberative (see e.g. Zajonc 1980, Epstein 1994, Sloman 1996, Pidgeon 1998, Chaiken and Trope 1999, Kahneman and Frederick 2002, Slovic et al. 2004, 2007, Wilson and Arvai 2006, Keller et al. 2006, Kahneman 2011). The message is that both System 1 and System 2 types of thinking are needed to properly react to and manage risk.

The literature on risk perception has demonstrated that mean values of the perceived seriousness of risks often deviate from mean or medium expert judgements or assessments of the same risks (Slovic 1987, Boholm 1998, Sjöberg 2000, Renn 2008). Politicians, hence, face a dilemma: if they base their risk policies on the expert judgements alone, they may lose public support; if they take the perceptions as guidance for their decisions, they are likely to spend their resources dedicated to risk reduction unwisely. They may finance costly risk reduction measures that are high on the public agenda but may only marginally improve human health and the environment, and they may not address serious risks because these are not perceived as serious in the public eye. It is evident that, from a normative perspective, knowledge about individual perceptions of risk cannot be translated directly into risk-reduction policies. Given the many insights from psychological research into the fact that perceptions are based partially on biases or ignorance, it does not seem wise to use them as yardsticks for risk reduction (Fischhoff et al. 1981, Slovic 1992, Wilson and Arvai 2006, Aven and Renn 2010). In addition, risk perceptions vary among individuals and groups: whose perceptions should be used to make decisions on risk?

At the same time, however, these perceptions reflect the real concerns of people and include the undesirable effects that 'technical' analyses of risk often miss. It is true that laypeople's views of risk are intuitive and less formal and precise than experts' statements. However, as Paul Slovic observed, "Their basic conceptualization of risk is much richer than that of experts and reflects legitimate concerns that are typically omitted from expert risk assessments" (Slovic 1987, p. 282).

In fact, laypeople's risk judgements indicate more than just the perception of riskiness. They reveal global views on what matters to people, on technological progress, on the meaning of nature and on the fair distribution of chances, benefits and risks. Facing this dilemma, how can risk perception studies contribute to improving risk policies? Pertinent benefits of revealed perceptions may be as follows (de Marchi 2015, Fischhoff 1985):

- They can identify and explain public concerns associated with the risk source.
- They can elucidate the context of the risk-taking situation.
- They can enhance understanding of controversies about risk evaluation.
- They can identify cultural meanings and associations linked with special risk arenas.
- Based on this knowledge, they can be useful when articulating objectives of risk policies that go beyond risk minimization, such as fairness, procedural equity and institutional trust.
- They can indicate how to design procedures or policies that incorporate these cultural values into the decision-making process.
- They can be useful in the design of programmes for participation and joint decision-making.
- They can provide criteria for evaluating risk management performance and organizational structures for monitoring and controlling risks.

Risk perception studies demonstrate what matters to people. In a democratic society, the concerns of people should be a guiding principle for collective action. Context and supporting circumstances of risk events or activities constitute significant concerns. These perception patterns are not just subjective preferences cobbled together: they stem from cultural evolution, are tried and trusted concepts in everyday life and, in many cases, control our actions. Their universal nature across all cultures allows a collective focus on risk and provides a basis for communication (Renn 2008, pp. 146–7). From a rational standpoint, it would appear useful to systematically identify the various dimensions of intuitive risk perception (concerns assessment) and to measure the extent to which these dimensions are met or violated by the best available scientific methods. Many psychometric variables that matter to people are open to scientific study and scrutiny. In principle, the extent to which different technical options distribute risk across various social groups, the degree to which institutional control options exist and the level of risk that can be accepted by way of voluntary agreement can all be measured using appropriate research tools. Risk perception studies help to diagnose these concerns. Scientific investigations can determine whether these dimensions are met or violated and to what degree. This integration of risk expertise and public concerns is based on the view that the dimensions (concerns) of intuitive risk perception are legitimate elements of rational policy, but assessment of the various risk sources must follow robust scientific procedures on every dimension.

Moreover, designing policies about advancing, supporting, and regulating risks requires trade-offs between different concerns. Such trade-offs depend upon both context and the choice of dimension. Perception research

offers important pointers concerning the selection of dimensions for focus (Rayner and Cantor 1987). For example, the aspect of fairness, which is rated highly among people as an evaluation tool for the acceptability of risks, plays a significant role in such trade-offs and in weighting the various dimensions. In their roles as risk assessors, experts have no authority to select these dimensions or to specify their relative importance. This is where formal methods reach their limits. The multidimensionality of the intuitive risk model prevents risk policy from focusing one-sidedly on the minimization of expected impacts or related metrics.

In essence, policy-makers should be aware of public perception and concerns and take them as a legitimate input to risk management and regulation. Yet, concerns may be associated with problematic or even wrong (poor) causal models or they may simplify these models to such a degree that they are not useful for effective risk management and regulation. Thus, as stated in SRA (2017b), public input is important for (i) identifying concerns but not necessarily for measuring their potential impacts and (ii) for providing value judgement with respect to unavoidable trade-offs in the case of conflicting values or objectives.

### 6.1.1 The difference between risk, professional risk descriptions and risk perception

Risk perception as used in this book is not the same as risk and professional descriptions or characterizations of risk. This is in contrast to, for example, scientists advocating cultural theory and constructivism, who state that *risk is the same as risk perception* (Jasanoff 1999, critical comments in Rosa 1998). Risk coincides with the perceptions of it (Douglas and Wildavsky 1982, Freudenburg 1989, Rayner 1992, Wynne 1992). Beck (1992, p. 55) states that "because risks are risks in knowledge, perceptions of risks and risk are not different things, but one and the same".

However, acknowledging that any risk characterization is knowledge-based and subjective/intersubjective does not mean that risk is the same as perceived risk. For example, a risk assessment can describe risk using knowledge-based probabilities, but these probabilities do not reflect perceptional aspects like fear and dread. The analyst may conclude that the probability of an event occurring is 0.1, meaning that he or she has the same degree of belief that this event will occur as randomly drawing a specific ball out of an urn comprising ten balls. The assignment is based on some knowledge (data, information, justified beliefs) but does not include aspects linked to how the assigner likes/dislikes the event or, for example, fears its consequences. A professional risk analyst is able to make a probability assignment without being influenced by such perceptional aspects. In practice, there

could of course be assignment problems, for example as a result of overconfidence and group-thinking (e.g. Pidgeon 1998).

Risk perception also sometimes covers judgements of the acceptability of risk, which makes the difference between risk perception and professional risk descriptions even more evident. The concept of risk and a professional description of it do not include judgements about risk tolerability or acceptability.

To discuss the issue in more detail, we return to the book, *Thinking, Fast and Slow*, written by Kahneman (2011), in which the author presents an example related to suicide bombings on buses in Israel in the period from 2001 to 2004; see Section 1.4. In this example, a professional analyst describes or characterizes the magnitude of the risk through the death rate and associated probabilities. From this basis, it is demonstrated that the risk is not higher than for activities that we normally conduct, like driving, and hence the risk associated with taking buses should also be acceptable or tolerable. System 2 thinking is used for this analysis. A bus rider, we call him John, is still concerned. His quick and intuitive judgement about risk is that it is too high; he will not take the bus if he can avoid it. He senses the uncertainties in relation to taking the bus – next time it could be his bus.

There are many factors or issues that could affect this System 1 thinking. For example, his risk judgements could be amplified (Kasperson 1992, Kasperson et al. 1988), as a result of the media, biases or heuristics (Tversky and Kahneman 1974) – for instance, the availability heuristic would make the most recent events the most salient ones – and his level of trust in the information and its sources.

His risk perception is based on System 1 thinking – which is intuitive, associative and automatic – which concludes that the risk is too high, and the bus-taking should be avoided.

Does this thinking express risk in some sense? Yes, it is an example of a risk perception reflecting the assessor's subjective judgement of the risk, which allows for considerations of affects and also includes issues of acceptability/tolerability (Renn 2008). But not risk *per se*? It depends on what risk *per se* is. If risk *per se* is the death rate or associated probabilities, the System 1 thinking is clearly not very informative. However, if risk *per se* is the potential for an unwanted event, or the possibility of such an event, or "damage + uncertainties" as in Chapter 4, the conclusion is not so straightforward. The potential, the possibility or uncertainties: we certainly have these in this case. John faces uncertainties – it is not known whether his bus will be attacked or not; there is the potential, the possibility. His System 1 thinking is perhaps responding to these uncertainties, this potential and possibility. So, perhaps the thinking nonetheless brings some useful information to the decision situation.

And if risk *per se* captures uncertainties, the potential and possibility, it probably also affects the way we should judge the magnitude of the risk. There is a gap between uncertainties, the potential and possibility, on the one hand, and a historical rate or related probabilities, on the other. The literature is filled with analyses and reflections on the issue of transforming uncertainties, potentials and possibilities into some measurement tool (e.g. Lindley 2006, Dubois 2010, Flage et al. 2014); see Section 4.2. Probability is the most common tool, but it has limitations, and many alternatives have been suggested. There are different views on what are the most suitable approaches and tools in this respect, but there should not be much discussion on the need to show some humility in being able to measure the risk. It has to be acknowledged that any measurement of uncertainties, potentials and possibilities would mean some level of subjectivity and would raise several issues. For example, if the historical death rate is used in our example to measure risk, it is based on an assumption of stability in the level of attacks. But who knows whether this assumption will hold for the period that John considers? It could increase or decrease, and the form of attacks could change. The next day, one or more new campaigns of attacks could be launched. These are issues that John faces and that could be reflected in his System 1 thinking, as well as in his System 2 thinking. John may be informed about the historical rate, but the poor knowledge that characterizes the situation can get System 1 to react, avoiding the risk.

With large uncertainties and poor knowledge about what is happening, is not cautionary thinking quite natural? Yes, it is. We do not walk on the ice on a lake if we do not have reliable information about its safety (how thick the ice is). Is not the situation similar in the bus example? The knowledge is also rather poor. System 1 reacts – the risk could be judged as too high. Kahneman drove away faster from the bus than he usually did when the light changed, as his System 1 reacted instinctively and automatically to the uncertainties and risk. Why should he be chagrined by this fact?

The traditional risk assessment and management thinking highlights the calculated death rate and gives little weight to the uncertainties. According to such a perspective, one could be chagrined, as risk then is considered minor. Adopting a different risk perspective: risk could, however, be judged as high, just by allowing for a broader understanding of risk.

It may be argued that the above analysis is very incomplete in that it is not only uncertainty that is relevant for the decision-making. We know from the risk perception and behavioural decision-making research that aspects like affect, control, familiarity, catastrophic potential, etc. are important. However, the focus here is not descriptive decision-making but normative decision-making: how we should make decisions. The idea is to separate what are pure risk judgements and characterizations, and what are risk

perceptional aspects, for example fear. Decision-makers may have different attitudes concerning the weight to be given to such aspects. To change professional risk assessment and management practice, we should be clear what we are trying to add: judgements of uncertainty or perceptional aspects.

In this book, a clear distinction is made between the risk characterization (C',Q,K) and risk perception. The risk characterization provides 'pure' judgements of the consequences and uncertainties, without adding feelings and value judgements related to how one likes or dislikes C and U. Risk perception, on the other hand, is a personal judgement of risk, also including such aspects. In the above example: taking the bus, John will face risk, as there are some values at stake – some consequences of the activity – and uncertainties. He may be filled with fear and his risk perception be very much flavoured by this. A risk characterization would, however, be restricted to pure judgements of the consequences and uncertainties and not be affected by perceptional aspects like fear.

### 6.1.2 Methodological issues related to risk perception research

Risk perception research studies how people perceive risk. This is conducted by conceptual and empirical analysis. An approach – a theory or model – is developed, which is to describe the 'world', i.e. how people in real life perceive and make decisions in relation to risk. Then, data are generated using different methods, including making a survey, in which information from a sample of individuals is gathered, for example by questioning how they perceive risk associated with specific activities (Sjöberg 2003). The data are interpreted in view of the approach (theory, model) used. See discussion in Section 3.2.2 of different types of research methods. Statistical inference represents a basic methodological framework for much of this research.

As an example, let us consider the so-called psychometric paradigm (Fischhoff et al. 1978, Slovic 1987). The approach aims at identifying the key factors that influence the perception of hazards. Starting from a set of factors – voluntariness of risk, immediacy of effect, knowledge of risk of those who are exposed, scientific knowledge, control over risk, newness, number of people killed in an incident, dread potential and high severity of an incident – the statistical analysis reveals two main contributors: dread and newness. From this result, a map is presented, which depicts a number of hazards in a two-dimensional space with these two factors. It is a map that is easy to understand and is one of the most popular figures in the science of risk analysis.

However, as for all statistical analysis of this type, there are pitfalls. The approach seems to indicate that the map fully explains laypeople's risk

perceptions, but this is not the case; see discussions in, for example, Sjöberg (2003) and Siegrist et al. (2005). The approach produces a model of the world and, as for all models, it has limitations and weaknesses. Yet, it can be useful for our understanding of how people perceive risk. There is and needs to be a continuous discussion about the research and what is the current knowledge on risk perception.

As highlighted above, the risk perception research has demonstrated that people's understanding of risk extends beyond the professional characterizations based on consequences (loss) and probabilities and, in particular, expected values with these two dimensions multiplied. As discussed in Section 6.1.1, traditional professional risk characterizations need to be extended, to make informed decisions in the face of risk, mainly for two reasons:

1) These characterizations do not capture all aspects of uncertainties (refer to discussion in Section 4.2).
2) Judgements about what risk to accept need to be seen in relation to other concerns, not only risk.

Risk perception takes into account the full spectrum of uncertainties, and includes judgements of acceptability. Hence, we cannot expect risk perception results to be comparable to professional judgements of risk, which make a clear distinction between risk characterizations and how to handle the risk.

## 6.2 RISK COMMUNICATION

We refer to the basic principles of risk communication in Section 3.1.1 (items 15–19). There is a huge body of literature on risk communication addressing this type of issue and related ones; see, for example, Covello et al. (1986), Fischhoff (1995), Bier (2001a, b), Bostrom and Löfstedt (2003), McComas (2006), Renn (1998a, b), Visschers et al. (2009) and Pidgeon and Fischhoff (2011). This literature provides concepts, theories, frameworks, approaches, methods and models for communicating risk, as we discussed in Section 3.1 (generic risk communication and risk analysis B). It also covers studies of risk communication for concrete activities (applied risk communication and risk analysis A), using the B type of knowledge. The research conducted is conceptual with strong elements of empirical work, see Section 3.2. Beyond the principles highlighted by SRA (2017b), a number of recommendations have been formulated on the basis of the risk communication research. As an example, Bier (2001a), presents the following recommendations in relation to designing risk communication messages:

> View risk communication as an opportunity to demonstrate trustworthiness and an open, responsible, and caring attitude. Listen to audience concerns before attempting to impart new information. Use risk comparisons with caution:
>
> 1. Consider presenting comparisons of the same risk at different times (e.g. a few years ago vs. now), comparisons with other causes of the same disease or injury, and comparisons with unrelated risks, such as the risk of lightning.
> 2. Avoid comparisons with risks that are generally viewed as trivial, such as the risk of eating a few tablespoons of peanut butter.
> 3. Pilot test risk communication messages (especially risk comparisons) on a limited basis before using them more widely, to ensure that they are easily understood and not misinterpreted. This is particularly important in situations of distrust.
>
> (Bier 2001a)

Reference is made to the above publications for other examples.

In the following, we will look more closely into some of the basic risk communication principles as formulated by items 15–19 in Section 3.1.1. The risk communication literature builds strongly on the concepts of risk and probability, and we will therefore focus on these concepts and discuss how risk communication is closely related to the science of risk analysis. We will also provide some comments concerning the policy of openness and transparency in risk communication.

### 6.2.1 Perspectives on the nexus between good risk communication and high scientific risk analysis quality

In general, successful risk communication can be said to require "an understanding of the target audience, including the best means for reaching the audience: a credible or trusted source; and a message that has ideally been pre-tested to ensure its effectiveness" (SRA 2017b). Seldom is the scientific quality of the risk analysis questioned. The sources can be credible or trusted, but the scientific risk analysis quality can be poor. For example, the risk communication can be based on a scientifically unsound risk characterization yet be communicated successfully from a pure communication point of view. Good risk communication cannot, however, be seen in isolation from the broader process of risk analysis and management. The present discussion provides some reflections on this topic, the main aim being to strengthen the argumentation for the thesis that scientific and foundational issues of risk analysis are critical for the successful communication of risk. Several examples are used to demonstrate this thesis.

To be somewhat more concrete, think about a hypothetical case, where a risk assessment for a process plant is conducted by a recognized consulting company and the results are communicated to the public and the decision-maker. A key result is that the risk – expressed as a computed probability – is found acceptable, according to some defined criteria. The activity studied is judged to be safe. Dialogue and interaction among all relevant stakeholders are also conducted. All parties, including the decision-maker, consider the consultancy company to be a highly credible and trusted source and conclude from this that they have been adequately risk informed and the risk communication process has been solid and positive in all respects. All involved perceive the communication as successful.

As another example, consider the current risk and threat level characterizations in relation to security issues; see for example UK (2018) and PST (2018) (further details are given below). People are informed by the authorities that the threat level is low, the reference being a low-judged likelihood. It is probable that the police security services have a good basis for their judgements, and it can thus be argued that the risk communication is successful – people are adequately informed.

But are these perceptions and judgements really enough to conclude that the risk communication is successful? No; successful risk communication cannot be seen as separate from the scientific quality of the risk assessments and the risk characterizations. It is necessary to question the extent to which the risk assessment and the risk characterization are in line with the scientific knowledge generated by the risk analysis field. There will always be discussions about what is the current risk analysis scientific knowledge, yet it is important to acknowledge that some quality references exist that extend beyond individual perceptions. The analysis group members may be confident that they are applying appropriate risk analysis concepts, approaches, principles and methods, but this does not mean that this is in fact the case, as the reference is the risk analysis science.

For example, in the security example, it can be argued that risk communication based on likelihood judgement alone can mislead the public. The problem is that the strength of the knowledge supporting the judgement is not really covered by the likelihood judgements used to characterize and communicate the risk level, as will be thoroughly discussed below.

As another example, consider climate-change-related risk and the associated risk communication of the Intergovernmental Panel on Climate Change (IPCC). For many people, the IPCC is indeed a credible and trusted source. Based on thorough analysis, involving a number of scientists, the IPCC has produced extensive characterizations of climate-change-related risk and uncertainties. However, from a risk science perspective, it can be argued that this risk communication is poor in many ways (refer to Aven and

Renn 2015). For example, the IPCC uses the likelihood/probability concept to express important findings, for instance that it is extremely likely (at least 95 per cent probability) that most of the global warming trend is a result of human activities (IPCC 2014a). The IPCC does not, however, provide a clear understandable interpretation of the likelihood/probability concept. The consequences are that people read this type of statement in different ways and have difficulties in understanding what the probability really expresses: does it reflect fundamental variation in physical phenomena, differences in expert judgements, different views about specific issues or something else?

If we read the media interpreting the IPCC work, the impression is that the IPCC expresses that science states that global warming takes place and is a result of human activities; the uncertainties are very small and can be basically ignored: the experts are confident that the statements referred to are true. However, the IPCC reports stress that likelihood and confidence statements should not be mixed ("Confidence should not be interpreted probabilistically" (IPCC 2010)). The 95 per cent probability statement is of course also related to confidence, but the IPCC reports seem to indicate that this is not the case. Thus, a deeper look at the IPCC platform on risk and uncertainty reveals that the analysis has some serious weaknesses. Acknowledging these, can we still argue that the risk communication is successful?

Clearly, what 'successful' means depends on what the reference is. The issue has been thoroughly discussed in the risk communication literature (e.g. Covello et al. 1986, Zimmennann 1987, Keeney and von Winterfeldt 1986, Renn and Levine 1991, Kasperson 1992, Fischhoff 1995, McComas 2006, Renn 2008). Examples of risk communication objectives include: enlightenment function, right-to-know function, attitude change function, legitimation function, risk reduction function, behavioural change function, emergency preparedness function, public involvement function and participation function (Renn and Levine 1991). Increasing trust and credibility is often seen as a key objective of the risk communication, and trust and credibility are also prerequisites for many other objectives (Renn and Levine 1991). Trust and credibility depend on how the receiver perceives the source when it comes to factors like competence, objectivity, fairness, consistency and faith. It is expected that the communicator conveys accurate, objective, and complete information (Renn and Levine 1991).

There is, however, a potential gap between what is perceived as competence, objectivity, etc. and what the scientific field claims. In the above examples, the sources may be viewed as trusted and credible, yet the risk communication can be considered unsuccessful from a risk science perspective.

In the following, this issue will be discussed in further detail: the nexus between risk communication and the scientific quality of the risk analysis, using the above examples as points of departure. The main aims are to

achieve increased awareness of this issue, as it is considered under-focused on today, as well as to obtain new insights into risk communication's dependencies on the scientific and foundational issues of risk analysis. The discussion is based on the conviction that current risk analysis practice is subject to many weaknesses of a conceptual and fundamental character, which have severe implications for the quality of the risk communication and risk management, as indicated by the above examples. Probability is a key concept in risk and uncertainty analysis, but lack of precision in the understanding and use of this concept hampers risk communication and management in many situations. The reference for what is good – high-quality – risk analysis is represented by the most warranted statements or justified beliefs that the risk analysis knowledge field can produce; refer to discussion in Chapters 2 and 3.

### *The IPCC risk communication*

The IPCC aims at informing governments and decision-makers at all levels on scientific knowledge about climate-change issues. Their work is, to a large extent, about risk. The communication can be viewed as successful, in the sense that most governments are now taking serious action in line with the main conclusions made by the IPCC. However, the scientific quality of the risk assessments and characterizations – and, hence, also the related risk communication – can be questioned.

Risk and probability are fundamental concepts in the IPCC work. However, clear definitions are not provided. As referred to above, it is a key message of the IPCC that it is very likely that most of the global warming trend is a result of human activities. A probability of 95 per cent is used to express this, but no interpretation is presented. The concept of risk in the IPCC works refers to probability but with no interpretation of probability; also, the concept of risk become undefined and vague. Equally important, significant aspects of risk are not really communicated. The point being made is that, to be used in relation to climate-change issues, a probability has to be viewed as a subjective probability, which is conditional on some knowledge. This knowledge can be more or less strong and even erroneous. This fact creates two additional dimensions of risk: first, a need to characterize the strength of this knowledge and, secondly, a need to consider surprises relative to the knowledge available (SRA 2015b, 2017b, Aven and Renn 2015). The IPCC works are not explicit on these dimensions, although the former is discussed in relation to statements when referring to evidence and agreement among experts. The problem is, however, as was mentioned above: there is no link between the probability judgements and the strength of knowledge judgements in the IPCC framework. The risk analysis science

clearly shows that such a link exists and is essential for understanding risk (SRA 2015b, 2017b, Aven and Renn 2015), refer to Chapter 4.

Most governments and decision-makers seem to trust the IPCC and its scientific results and find the IPCC to be a credible source for communicating the climate-change-related risks. The concerns raised by risk analysis have not influenced this trust and credibility. It can be argued that these concerns are not of a significance that changes the overall important conclusions from the IPCC: rather, they should be seen as details on a technical level.

However, this type of reasoning is easily rebutted. It represents a dangerous attitude to science, which, per definition, seeks to identify and use the most warranted statements and beliefs that the knowledge disciplines can produce (Hansson 2013a, Hansson and Aven 2014). Risk analysis is a key science in relation to all types of risk knowledge generation, including climate-change-related risk. One of its main focus areas is risk conceptualization and characterizations. It provides authoritative guidance – the key principles – on how risk should be best described to inform decision-makers and other stakeholders. Violations of these principles can strongly influence the way risk is understood.

For example, when using the term 'probability of 95 per cent' to express that it is very likely that most of the global warming trend is a result of human activities, it matters greatly whether this is a statement reflecting some objective physical phenomena in the world or whether it is the view of some experts. The IPCC is not clear on this point but indicates in a rather imprecise way that the probability is linked to variation and, thus, some physical phenomena. This type of interpretation gives the probability statement a stronger scientific basis than if we are to interpret the probability as a subjective probability. Although the latter type of probabilities can be given a rigorous foundation (Lindley 2006, Section 4.2), it represents a challenge in risk communication, as it is a judgement made by someone.

Openness and traceability on such matters characterize high-quality risk analysis. However, these issues are not discussed in the existing IPCC documents. There is no reason to believe that the current imprecision on key concepts in these documents is a deliberate policy to strengthen the objective authority of the IPCC findings. However, the imprecision opens the door to legitimate criticism, as the 'objective variation type of interpretation' is not justified. In fact, on the basis of the scientific risk analysis work referred to, the risk analysis science would conclude that it cannot be justified, as there is no objective foundation for such a probability in a case like this. Knowledge-based probability is the only one that can be meaningfully defined. According to this thinking, the assessor has a strong belief that most of the global warming trend is a result of human activities, but it must be acknowledged that this is a belief conditional on some other

beliefs (knowledge). It does not mean that the statement is true in at least 95 out of 100 cases, as is often used to explain probabilities. This type of interpretation has no meaning in this context. Rather, we must think of the uncertainty and degree of belief as comparable with drawing a red ball randomly out of an urn comprising 100 balls, of which 95 or more are red. The interpretation does not reflect any type of variation or features of the real world, although variation and such features can be used as input to the judgements of the uncertainties.

On this basis, it can be claimed that the current IPCC risk communication misinforms decision-makers and other stakeholders. The risk communication fails from a risk science perspective.

Solidity is a basic requirement for a high-quality assessment, as was discussed in Section 3.1.1. Not being precise on the meaning of key concepts violates this requirement. This is not about semantics as such but about the fundamental risk thinking that has considerable influence on how the results and findings of the IPCC work are reported and communicated. It is also about lack of validity, as the aim of the IPCC work is to adequately characterize risk. Important aspects of risk are neither explained nor addressed, as discussed above and in greater detail in Aven and Renn (2015).

### *Security risks*

Consider as an example the UK Secret Services' approach to expressing threat levels (UK 2018). Five categories are used: "LOW means an attack is unlikely, MODERATE means an attack is possible but not likely, SUBSTANTIAL means an attack is a strong possibility, SEVERE means an attack is highly likely, and CRITICAL means an attack is expected imminently" (UK 2018). In Norway, a similar categorization is used by the Norwegian Police Security Service (PST): "*Very likely*: There is very good reason to believe, *Likely*: There is reason to believe, *Possible*: About as likely as not, *Unlikely*: There is little reason to believe, *Very unlikely*: There is very little reason to believe" (PST 2018).

Now, suppose a case where the assessor's belief that an attack will occur is considerable but far from 50 per cent, and the supporting knowledge is very strong. How should the assessor classify and communicate this? Using the above systems is difficult. Of course, any classification system would have weaknesses and limitations, but the current systems mix likelihood judgements and the knowledge supporting these judgements. The result is confusing terminology and communication. An attack is always possible, and what does "strong possibility" mean? Using subjective (knowledge-based) probabilities – preferably as intervals – clarity can be obtained, as well as more informative communication. The assessors' judgements are

based on the available intelligence and possible attackers' capabilities and intentions, but, using the current classification systems, the strength of this information and knowledge is not communicated to the public in an informative way – important aspects of risk are suppressed. We again see how risk analysis insights are important, to ensure good risk communication. See Aven (2013c) for an alternative threat level classification system based on the ideas presented in this book.

### *Industry safety case*

We return to the industry example introduced above. In this case, all involved parties found the risk communication successful in all respects, but, nonetheless, there could be reasons to question the quality. The approach taken serves the interests of the operator of the plant and the consultancy company, and the public and decision-makers did not have the competence needed to challenge the risk assessments conducted. The overall perception is that the risk assessment and related management processes are conducted in line with well-established standards, like the ISO 31000 on risk management. There are no incentives for the operator and consultancy company to see beyond these standards and their own in-house procedures.

There may, however, be a gap between this practice and the scientific knowledge on risk assessments. This gap can be unknown to the consultancy company or not acknowledged as a gap. Their authority as a recognized consultancy company would suffer if it became known that the approach adopted is not in accordance with the best available scientific insights. The result is that weaknesses and delimitations of the assessment approaches and methods are often suppressed.

To meet this challenge, the relevant safety agency has a responsibility. It needs to be updated on current scientific developments. However, in practice, there is often a considerable delay between the knowledge of the scientists and the regulations and industry practice. Also, the agencies may face a dilemma in acknowledging that important scientific findings on how to conduct the risk assessments exist but not implementing them in official regulatory documents. The implications are often that the agencies are also passive in relation to questioning the practice of the consultancy companies.

A debate on the risk analysis approach can still arise, as members of the public may be unhappy with the conclusion of the risk management and start to look for ways of questioning its rationale. Then, experts on risk analysis are contacted, often resulting in findings of problematic issues linked to the approach and methods used. The gap between science and practice is pointed to. There could be various motives for these experts being involved and allowing their voice to be used to challenge the consultancy companies, but usually their judgements add alternative and new perspectives to the

understanding of risk as presented by the consultancy and operator. Here is an example, inspired by discussions in Aven (2011b).

The consultancy and operator communicate that the plant is safe by referring to a derived risk level expressed in the form of probabilities of undesirable events. The argumentation is that the plant has no unacceptable risks. However, as discussed in Section 4.2, risk is in general poorly described by reference to probabilities alone. The probabilities can be based on a more or less strong knowledge, and this strength also needs to be considered and communicated, along with the probabilities. In addition, the fact that surprises can occur relative to current knowledge also needs to be addressed, as the public will be exposed to these. Not addressing these issues, as often seen, means camouflaging important aspects of risk. The public is not properly informed about the risks. The risk communication fails in informing the public.

In most cases, the public will not have the competence to challenge the consultancy companies and operators, as the risk assessments are technical and use terminology which is difficult for laypersons to understand. Yet, the risk communication cannot be judged as successful just by observing that all relevant parties are pleased with the approach taken or do not have reasons to question it. The risk science is also a relevant party and needs to be included when making judgements about the quality of the risk communication.

### *Discussion*

Moser (2010) provides an informative review of fundamental research findings on risk communication as applied to climate change. The author distinguishes between three main categories of communication purposes. The first one concerns informing and educating people about the issue, here climate change. The second purpose is to obtain some type and level of social engagement and action, whereas the third category aims at bringing about changes in social norms and cultural values that act more broadly. Only the first one is addressed in the current discussion. The other two categories are interesting from a risk communication point of view, given the stated purpose, but defining these purposes is founded on value judgements that extend beyond the science of risk analysis.

Research on risk perception and communication has clearly demonstrated that understanding risk requires more than informing and educating people about risk estimates (Pidgeon and Fischhoff 2011). Such estimates are not enough to bring laypeople an understanding of risk in line with scientists' expectations. To affect people's behaviour is even more difficult. We know that people's risk perceptions and related decisions are affected by a number of factors and also feelings (Slovic et al. 2004, Fischhoff 1995, Pidgeon and Fischhoff 2011), but this discussion is outside the scope of the

present analysis. Here, the focus is on the scientific understanding of the concept of risk, not on how people choose to react to this risk. An interesting question is whether an enhanced risk science and related risk communication would have the potential to provide people with an improved scientific risk understanding and establish a stronger separation between people's scientific risk understanding and what are perceptional aspects. Surely, simply characterizing risk through some probability numbers would create a gap between people's risk characterization and their intuitive risk understanding, the result easily being that this 'risk gap' is mixed with the risk perceptional factors when trying to explain people's attitude to risk, as discussed in Section 6.1.1.

The critical issue seems to be that important aspects of uncertainty are not captured by current risk conceptualizations and characterizations. The industry example illustrates this clearly. The professional risk descriptions and related communications highlight probabilities and statistical expected values, and risk considerations beyond these are judged by the risk analysis professionals and the industry – often also the safety authorities – to be highly subjective risk perceptions of a different value and importance, compared to the 'objective' risk characterization produced by the scientists and analysts. However, the current risk analysis literature provides strong support for the acknowledgement that uncertainty is a main component of risk, and people's judgements of risk can, thus, be far more informative than a narrow probabilistic representation and communication of risk.

An illuminating security application is presented in Sections 1.4 and 6.1. Here, historical data are used as a reference for the risk considerations, and it is argued that, if risk is assessed as being higher than is indicated by the data, it is irrational and perceptional aspects like fear are dominating the judgements. However, people's judgements in the situations considered can equally be seen as serious deliberations of the uncertainties and risk, where perceptional aspects like fear are not an issue at all. Depending on the perspective taken, the risk communication will be completely different. The present book argues that only the latter perspective represents high-quality risk analysis.

The same type of discussion is also relevant for the climate-change case. Here, the uncertainties are clearly acknowledged and communicated by the IPCC, but based on characterizations which are not complete and convincing. First, probabilities are referred to, which are not well-defined, giving the impression that these probabilities are more scientific than can be justified. Secondly, the strength of the knowledge supporting these probabilities is not described, as the IPCC framework fails to link probability judgements and knowledge, as discussed in Section 4.2.2.

### *Conclusions*

Successful risk communication can be defined in relation to different purposes. The present discussion focuses on the information and education purposes. Although the competence of the risk-communication sources is always an issue when discussing the success of the communication, the dependence on the quality of the risk analysis as such is seldom addressed. The above analysis has pointed to this fact and provides discussions and examples illustrating the problem.

Applied risk analysis is to be guided by the science of risk analysis, on which concepts, principles and approaches to use, to adequately analyse and communicate risk in practical cases. There will be and should be a continuous debate about what constitute these concepts, principles and approaches, but, at a specific point in time, the discipline of risk analysis needs to define and communicate what is its current knowledge. The work by SRA on these issues and the present book represent contributions to this end.

## 6.2.2 Risk communication in the light of different risk perspectives

A risk perspective contains the fundamental building blocks forming the understanding of risk and can be based on scientific pillars and/or more informal conceptions and judgements of risk (risk perceptions). In the following, we discuss how the risk perspectives of various actors influence risk communication in relation to processes concerned with the assessment and management of risk. Based on a set of five defined risk perspectives, we investigate how the risk perspective influences the risk communication and how and to what extent differences in risk perspectives can cause barriers and problems in the communication.

The handling of risk in society is ultimately carried out by people. A central activity for any successful risk-handling process is the exchange of risk-related information between them. Many different factors can affect how the actual risk communication takes place. The focus in the following discussion is on how the risk perspectives of the involved people can influence the risk communication. We will study five types of risk perspectives:

- The actor believes in an underlying objective risk, and risk analysts and experts provide good estimates of this risk.
- The actor believes that uncertainty is a main component of risk and that probability is a useful tool for describing the uncertainties but also acknowledges that this tool has strong limitations.
- The actor believes in an underlying objective risk based on frequentist probabilities reflecting stochastic (aleatory) uncertainties but considers

"non-probabilistic" methods to be the appropriate tool to describe epistemic uncertainties (the use of subjective probabilities is rejected unless the information is very strong). These alternative approaches include imprecise probability and so-called evidence theory (see e.g. Aven et al. 2014).

- The actor has a 'chaotic' understanding of risk, with no proper scientific basis, lacking a proper understanding of fundamental concepts like risk, probabilities and uncertainties, and/or mixing various ideas about these concepts.
- The actor sees risk as the same as risk perception.

We refer for short to these perspectives as the 'objective risk view', the 'uncertainty view', the 'non-probabilistic view', the 'chaotic view' and the 'risk=perception view', respectively. For the first three perspectives, which all have a professional/scientific basis, although founded on different pillars, there is a fundamental distinction between risk and risk descriptions carried out by experts, on the one hand, and risk perception, on the other, as discussed in Section 6.1. The perception notion includes personal feelings and affections (e.g. dread) about the possible events, the consequences of these events and about the uncertainties and probabilities, but such feelings and affections are not considered as part of the risk concept *per se* and the way risk is described when used in professional/scientific contexts.

The set of perspectives here defined is considered to reflect common perspectives seen in practice. Many perspectives other than these five exist, but, for the purpose of the present work, this set is considered to be sufficiently representative.

Of course, the objective view actor could also be aware of uncertainties and acknowledge that the different tools used have limitations. It must be emphasized that it would be possible to define several perspectives between the objective view and the uncertainty view, and also between some of the other perspectives, but, to simplify the analysis and make the points clear, attention is restricted to the five commonly adopted views presented above.

Since the risk perspective of an actor forms his/her fundamental understanding of risk, it can affect his/her risk communication. This is the issue discussed in the following analysis. We consider four categories of risk actors – a decision-maker, a risk analyst, an expert and a layman (from the general public). Using a set of communication scenarios that resemble situations commonly found in reality, such as the risk analyst presenting the result of a quantitative risk assessment to the decision-maker, we study how differences in the risk perspectives influence the exchange of information about risk between these actors. We try to identify some main challenges and barriers in the risk communication in the different situations.

**TABLE 6.1** The different communication scenarios discussed, with an indication of which actors are involved (marked with an x) (based on Veland and Aven 2013)

| Actor<br>Scenario | Decision-maker | Risk analyst | Expert | Laypeople |
|---|---|---|---|---|
| 1. A risk analyst presenting the result of a quantitative risk assessment to a decision-maker | x | x | | |
| 2. An expert providing risk-related input about the occurrence of a specific type of event to a risk analyst | | x | x | |
| 3. A risk analyst presenting the result of a risk assessment to laypeople | | x | | x |
| 4. A decision-maker communicating with laypeople on a risk-related issue | X | | | x |

### *Discussion on how the risk perspectives influence the risk communication*

The issue to discuss is how the risk perspectives, based on the five views on risk defined above, influence the risk communication between the four actors defined: decision-makers, risk analysts, experts and laypeople. The discussion is based on a set of scenarios, as shown in Table 6.1. For each scenario, we will discuss possible communication problems and barriers resulting from the risk perspectives of the involved actors. Where appropriate, we will also reflect on ways the actors can reduce these negative effects.

In the following, we look more closely into these four scenarios, linking them to the relevant actors and their risk perspectives.

### *Scenario 1: A risk analyst presenting the result to a decision-maker*

Let us start with the not uncommon situation that both actors have a chaotic view. Fundamental concepts like probability, uncertainty and risk are not properly understood, and no scientific foundation is present that can provide proper interpretations of the quantities presented. Clearly the situation would lead to poor communication. The analyst will fail in transmitting his/her message to the decision-maker. The results from the analysis include a number of probabilities and expected values, but, without clear and easily understandable interpretations, it will not be possible for the decision-maker to appreciate the meaning of these figures. If the analyst refers to an assigned probability equal to 0.2 (say), the meaning of this number must be explained in a way that is comprehensible, and if the risk perspective of the

analyst is a chaotic one, he/she is not able to do this. Another aspect is the context in which the numbers are produced. What are the assumptions on which the assessment results are based? With a chaotic view, the analyst can produce formulas and numbers but hardly any meaningful comments and reflections on the tool used to describe the risk, which would be essential for the decision-maker to fully understand the quantitative analysis carried out and place the result in its correct context, taking into account the limitations and boundaries of the assessment. If the decision-maker has a chaotic view, he/she is not able to ask for the key information required to support the decision-making. The lack of conceptual precision would in practice lead to a completely meaningless communication between these two actors.

Now, suppose that the decision-maker still has a chaotic view, but the risk analyst has one of the perspectives 1–3. This is a common situation in real life, as the analysts are trained as risk analysts and consequently have some background in the scientific pillars of the risk field, whereas the decision-maker normally lacks such training. The analyst is aware of the fact that the decision-maker lacks competence in the risk field and may seek to meet this challenge by trying to keep things simple and avoiding discussions of uncertainties (Aven 2011b, p. 125). However, in this way, risk could be poorly described, as uncertainty is an important dimension of all the risk perspectives. Even if the decision-maker lacks fundamental training in risk, the risk communication can be informative, provided that the analyst does his/her job in a professional way. Managers and politicians are able to relate to and deal with uncertainties and risk; these tasks are largely what their job is all about – to make decisions under uncertainty and risks. Managers are usually well-equipped people, who will quickly understand what is at stake and what the key issues are, if the professionals can do their job. The problem is, rather, that the analysts are not able to report the uncertainties and present them in an adequate way.

Next, suppose that the decision-maker has the 'objective view', whereas the analyst has either the 'uncertainty view' or the 'non-probabilistic view'. Problems can then easily arise, as the decision-maker is expecting to see some objective results – the truth about risk – whereas the analyst presents a subjective risk-uncertainty description. In this case, there is a need for a thorough process to make the decision-maker understand and acknowledge the analyst's perspective. Strong arguments for adopting such a perspective are then clearly required, to convince the decision-maker to give weight to the results and use them in the decision-making process.

Finally, let us consider the situation in which the analyst has the 'non-probabilistic view' and the decision-maker the 'uncertainty view'. Here, the communication could be challenging, as the decision-maker is not familiar with the non-probabilistic methods, and the presentation of these alternative

ideas is not done in a way that makes it possible to fully appreciate their meaning (based on the author's experience, these are common situations in real life). The decision-maker may find that the analyst addresses some relevant and interesting points, but, as the presentation of these ideas is so poor, he/she may be reluctant to give weight to the findings.

### *Scenario 2: An expert providing risk-related input to a risk analyst*

Now, we study scenario 2: an expert providing risk-related input to a risk analyst. Let us first consider a situation in which the expert has a 'chaotic' view on risk and the risk analyst has one of the scientifically founded perspectives, 1–3. In this situation, the risk analyst is equipped with precise concepts and tools to understand and systemize risk, which can be used as a guide for dealing with the input given by the expert. This does not necessarily mean that the communication between the expert and the risk analyst will be unproblematic. If, for example, the risk analyst has an objective interpretation of risk (risk perspective 1 or 3), the expert can experience the risk analyst as being too narrow-minded, because of the extensive use of frequency-based probabilities in the analysis. This can create resentment from the expert, because of the scope of the input requested by the risk analyst. If, on the other hand, the risk analyst has a risk perspective in which uncertainty is the main component (risk perspective 2), the view on risk is wider, and input about underlying assumptions and limitations is considered to be equally important. In this case, it is reasonable to believe that an expert with a chaotic risk perspective will bear less resentment towards the risk analyst. However, in this case, problems may also occur in the risk communication, as the expert has difficulties in understanding the concepts used by the analysts, for example knowledge-based probabilities.

Next, suppose that the expert has an 'objective view' on risk and the risk analyst has an 'uncertainty'-based risk perspective. In this case, the expert has a scientifically founded perspective on risk, based on the assumption that an objective, true risk exists. This situation could quickly lead to a discussion on fundamental issues about how to understand and describe risk and the use of different types of probabilities. The expert would like to estimate the true risk (frequentist probabilities), whereas the analyst is concerned with describing uncertainties (typically using knowledge-based probabilities). From the analyst's point of view, the differences in underlying perspectives need not be a problem in the communication, as long as the experts provide the information that the analyst needs: probability assignments and the knowledge and assumptions that they are based on. These assignments can be elicited by asking for frequency type of judgements, for example: in the case of 100

similar situations, for how many would you predict that the event of interest would occur? From this judgement, a knowledge-based probability can be assigned, but the experts need not use or refer to such probabilities themselves. This would not resolve the differences in perspectives but would meet the information required by the analysts. It is likely then that the experts would agree to provide input to the analyst, if the communication about the overall approach and thinking is made clear by the analyst. The expert may not agree on the suitability of the analyst's perspective but has no problem in providing the input asked for.

We can make similar arguments for the case in which the expert has an 'objective view' on risk and the risk analyst has a 'non-probabilistic'-based risk perspective. Here, both actors believe in an objective risk, but the expert may not be familiar with the non-probabilistic methods to describe the epistemic uncertainties. Hence, the analyst needs to put a lot of energy into explaining the relevant concepts and requesting information in a format that is suitable for the experts.

### *Scenario 3: A risk analyst presenting results to laypeople*

Next, we study scenario 3: a risk analyst presenting the results of a risk assessment to laypeople. First, suppose that both the risk analyst and the laypeople have a 'chaotic view' on risk. This would mean that the results from the risk assessment presented by the risk analyst would have no scientific foundation and, thus, lack precision and consistency. In such a situation, public scrutiny would most likely identify and emphasize weaknesses in the methodology and results. The risk analyst would fail to provide a credible response to this criticism, because of the 'chaotic view' on risk that the risk assessment is built on. Further, criticism from laypeople founded on a 'chaotic view' on risk would result in a rather meaningless communication between the two actors. In the end, the laypeople would not trust the risk analyst. Low levels of confidence and trust between the actors represent a core barrier to establishing a common understanding of risk between them.

Now, let us assume that the risk analyst has adopted the 'objective risk view', while the laypeople have the 'risk=perception view' on risk. This situation was typical in the 1970s and 1980s, for example in relation to nuclear power plants, when the risk analysts tried to convince laypeople that this industry is safe (having low and acceptable risk). Similar situations are also common today (Aven 2011c). The results presented describe the risk analyst's estimate of the 'true' risk level, represented by frequentist probabilities, based on past experiences and knowledge. The risk perceptions of the laypeople are shaped by the beliefs and conceptions of individuals and groups and can be further amplified or attenuated by social processes in society (Kasperson et al. 1988). A typical communication barrier in this

situation is that laypeople question the basis on which the results are built, for example conditions not included in the risk assessment or assumptions not adequately reflecting the present situation or the future. Another barrier is the analysts' use of criteria expressing that risk is acceptable by reference to low computed probabilities. This type of argumentation cannot be justified, as risk is more than probabilities (refer to Section 4.2) and laypeople also protest against it. Risk communication on this basis could lead to public criticism, which in its turn could amplify the laypeople's concerns and, thus, increase the barrier to communication and risk understanding between the two actors.

Let us now consider a situation in which the risk analyst has an 'uncertainty view' on risk and the laypeople still have a 'risk=perception view'. The risk assessment could still be largely based on probabilities, but the uncertainties are given more weight. With an 'uncertainty view', a broader risk picture is produced, reflecting the knowledge and the lack of knowledge on which the probabilistic analysis is based. Laypeople could question the quality of the analyses and their results, as they are not used to expert reports which do not provide clear answers. There seems to be growing understanding among people that things are complex and uncertainty is an issue we cannot ignore. People are faced with uncertainties in relation to potential pandemics, in relation to terrorist attacks, etc. They will understand that there are no numbers that can fully describe the risk in such situations, provided the analysts and experts do their job properly, i.e. establish a strong scientific platform for their thinking and the communication on the risk and uncertainties. Creating trust among laypeople is difficult but is certainly dependent on the analysts' and experts' ability to talk about the risk and uncertainties in the right way. Unfortunately, such a platform is not always established.

### *Scenario 4: A decision-maker communicating with laypeople*

Finally, we look into scenario 4: a decision-maker communicating with laypeople on a risk-related issue. There are many similarities between this scenario and scenario 3. The main difference is that, for scenario 3, the communication from the risk analyst is limited to the results from the risk assessment, while, in scenario 4, the decision-maker has a broader view on risk, where values could also play an important role in the communication.

Let us first consider a situation in which the decision-maker has an 'objective' perspective and the laypeople either a 'chaotic' or a 'risk=perception' view on risk. The decision-maker could now be inclined to mainly emphasize the results from the risk assessment in the communication, because of an underlying belief that the results provide the best available measure on the

'true' risk level. The 'true' risk level could thus be presented to the laypeople as the main argument for making a decision on the risk-related issue, and other aspects could be downgraded or left out in the communication. The likely response from the layperson could range between the two extremes of either trusting the decision-maker for making firm and reliable statements or showing a total lack of faith in the decision-maker, due to the missing concern for wider aspects related to the risk issue. The acceptable risk issue in relation to nuclear power is, again, a good illustration of the scenario.

Let us now consider the situation in which the decision-maker has an 'uncertainty view' on risk and the laypeople have a 'chaotic view' or 'risk=perception view'. What was said above for scenario 3 is also to a large extent relevant here, but the value issue has some interesting implications. Too great a focus on uncertainties could weaken the conclusions that the decision-makers would like to make, and they could be tempted to conceal the uncertainties or argue that they should not be given much weight. It is obvious that it could be challenging for the decision-makers to adopt this perspective in many cases, as the focus on the uncertainties means that they cannot easily communicate with strength that a solution is really safe.

### *Conclusions*

In this discussion, we have defined five perspectives on risk and four risk communication scenarios, based on commonly found real situations. By assigning different risk perspectives to the risk actors in each of these four scenarios, we have demonstrated the possible effects that differences in risk perspectives can have on the risk communication between them. The above analysis shows that differences in risk perspectives can lead to serious problems and barriers in the risk communication. Table 6.2 presents the main findings of the analysis.

A key finding of this analysis is that the risk communication can be seriously hampered if the risk assessment and management lack a proper scientific platform. On the other hand, if a solid platform is in place, it is much more likely that the risk communication will work effectively, as the premises for the dialogue are clear. The main barriers to good risk communication are not the laypeople's poor understanding of the risks and the risk assessment tools, but the risk analysts who have not done their job in a professional way and established some scientific pillars for their work. In this book, arguments are provided for using the uncertainty view, as it is very general and founded on a logical dichotomy: between the risk concept, which is based on uncertainties, and the way risk is measured or described, in which the probabilities and other representations of uncertainties come into play. However, which perspective is to be preferred is not the issue in relation the discussion in this section. Independent of the perspective adopted, the requirement for

**TABLE 6.2** An overview of the main findings of our analysis

| Scenario | Observation 1 | Observation 2 | Observation 3 | Observation 4 |
|---|---|---|---|---|
| 1. A risk analyst presenting the result to a decision-maker | If both actors have a chaotic view, the risk communication is meaningless | If the decision-maker has a chaotic view but the risk analyst has one of the perspectives 1–3, risk communication can be informative, provided the analyst is able to adequately report and communicate the probabilities and uncertainties | If the decision-maker has an objective view and the analyst either an uncertainty or non-probabilistic view, problems arise, as the decision-maker is expecting to see objective results | If the analyst has the non-probabilistic view and the decision-maker the uncertainty view, the decision-maker may find it difficult to appreciate the results, as he/she is unfamiliar with the non-probabilistic methods and how the results are presented |
| Suggested improvement measures | The risk analyst needs to establish a scientifically based risk perspective | The risk analyst needs to develop a risk communication scheme, which is based on a clear understanding of the meaning of the probabilities and the uncertainties | There is a need for a communication process to make the decision-maker understand and acknowledge the analyst's perspective | There is a need for a communication process to make the decision-maker understand and acknowledge the analyst's perspective. Considerable effort may be required, as the non-probabilistic view could be challenging to understand |
| 2. An expert providing risk-related input to a risk analyst | If the expert has a chaotic view and the risk analyst an objective view, the expert can experience the risk analyst as being narrow-minded | If the expert has an objective view and the risk analyst an uncertainty-based risk view, this could lead to a discussion on fundamental issues about how to understand and describe risk | If the expert has an objective view and the analyst a non-probabilistic view, severe communication problems may occur, as the expert may not be familiar with the non-probabilistic methods and their rationale | |
| Suggested improvement measures | The analyst needs to explain relevant concepts and request information in a suitable format | The analyst needs to clearly communicate to the expert the overall approach and thinking, so that the expert can provide input in the format required | The analyst needs to explain relevant concepts and request information in a suitable format | |

*(continued)*

**TABLE 6.2** *(continued)*

| Scenario | Observation 1 | Observation 2 | Observation 3 | Observation 4 |
|---|---|---|---|---|
| 3. A risk analyst presenting results to laypeople | If both have a chaotic view on risk, communication would be meaningless – the analyst would fail to provide a credible response to public criticism | If the risk analyst has an objective view and the laypeople a risk-perception risk view, laypeople will question the basis that the results are built upon and disagree if the objective results are used to conclude on risk acceptability | If the risk analyst has an uncertainty view and the laypeople a risk-perception risk view, a broad risk picture is presented reflecting the knowledge and lack of knowledge, which could make laypeople question the quality of the analyses | |
| Suggested improvement measures | The risk analyst needs to establish a scientifically based risk perspective | The risk analyst needs to provide meaningful responses to public criticism, which acknowledge the difference between the underlying risk and its estimate with associated uncertainties, in order to gain the trust of laypeople | The risk analyst needs to clearly establish and communicate a strong scientific platform for his/her thinking, to gain the trust of laypeople | |
| 4. A decision-maker communicating with laypeople | If both have a chaotic view on risk, communication would be meaningless – the decision-maker would fail to provide a credible response to public criticism | If the decision-maker has an objective view and the laypeople a chaotic or risk- perception view on risk, the likely response from the laypeople could range from full trust to a total lack of faith in the decision-maker | If the risk analyst has an uncertainty view and the laypeople a chaotic or risk- perception view on risk, too much focus on uncertainties could weaken the conclusions that the decision-maker would like to make | |
| Suggested improvement measures | The decision-maker needs to establish a scientifically based risk perspective | The decision-maker needs to acknowledge the difference between the underlying risk and its estimate with associated uncertainties, in order to gain the trust of laypeople | The decision-maker should be honest about the involved uncertainties and strive for a balanced characterization of the uncertainties | |

professionalism in relation to the scientific platform is the key. If a concept is introduced, it must be given a meaningful definition and interpretation. That is unfortunately not the case today in many situations (e.g. Aven 2012a). The objective view faces problems other than, for example, the uncertainty view but, even for the objective perspective, meaningful communication can be obtained if due consideration is given to the understanding of the concepts introduced and the uncertainties involved. There has been a tendency for risk analysts and decision-makers coming from the objective perspective to conceal uncertainties, and we see that this is still often the case (e.g. Aven 2011c). On the other hand, in following the uncertainty view, we may experience the other extreme: that too great a focus is placed on the uncertainties. What is the proper level is for the risk assessment discipline to decide, through the establishment of proper scientific principles and methods, as presented in the present book. More research is required on this issue, but equally important is the recognition among risk professionals that meaningful risk communication relies on a solid scientific basis. Improvements must be made in this area to bring forward risk analysts and also decision-makers that have the necessary competence and understanding for these matters.

### 6.2.3 The dilemma between being authoritative and open/transparent

History has shown that authorities and governments are not always open and transparent about their understanding of the nature of risks to the public and about the process they follow in handling them. Two illustrations are the so-called 'mad cow disease' (Creutzfeldt-Jakob disease) in the UK in the late 1990s (Powell and Leiss 1997) and the nuclear risk in the 1970s and 1980s (HMSO 1988). The perspective taken was that the risks were well managed by private companies and public regulatory authorities and were essentially negligible. The uncertainties were not properly acknowledged or communicated. Such a 'we know best' strategy led straight to the lack of trust in the authorities that many agencies and risk management institutions face today. Most people assume that the authorities try to balance different concerns and interests and like to avoid 'unnecessary' stress and panic. That is one reason for their suspicion, if the authorities pursue a typically paternalistic style of risk management and regulation. The authorities will lose public trust and lack credibility when they justify their decisions. We also observed this effect in relation to the swine flu vaccine (Rubin et al. 2010). Public authorities said little about the potential negative side effects of vaccination, in order not to worry the public. It was exactly this attitude, however, that created public outrage in many countries.

The authorities are of course faced with a dilemma. Although openness and transparency are in general desirable, their uncritical use can have severe

negative effects, such as stress and panic in huge populations. Yet, empirical research has demonstrated that open information about potential threats has very rarely resulted in panic or over-cautious behaviour (Helsloot and Ruitenberg 2004, Quarantelli 1993). On the contrary, when information is withheld and then suddenly released by third parties, panic reactions are more likely to occur. Given the overwhelming evidence in this issue, a policy of openness and transparency should be endorsed and practised. It helps people to be aware of the risks that they face and, in the long run, to build trust in the authorities.

People today seek the best information available. Public authorities should take a leading role, not camouflage their knowledge. The challenge is to develop a professional language and terminology that makes this communication work effectively. Current practice is not sufficiently developed to characterize and communicate risk and uncertainties in a way that different target audiences can make sense of and act accordingly. Public authorities need to invest extra effort not only to make information available to the general public (by placing it on a more or less open web account) but also to initiate communication programmes for each of the relevant stakeholders and target audiences. A huge challenge for authorities is to make scientific and professional reports comprehensible for the public. The transformation process may easily lead to biases – at least for one party in the debate. It is not sufficient to refer to probabilities – it is also necessary to say something about the knowledge base on which these are founded. If we think again about the swine flu example, a balanced way of expressing the risk would be to say:

> The vaccine could have unknown side effects. Some of them are known and we can control them, others are not and we do what we can to investigate and monitor them. We think it is unlikely that severe side effects will occur, but the knowledge base is rather weak and we cannot exclude the possibility.
>
> (Aven 2015b)

What is balanced can of course be discussed. In Aven and Renn (2018) it is mentioned that one of the reviewers of that paper commented that the parents of a child who developed narcolepsy as a consequence of the vaccination would probably not call this expression of risk balanced – they are now suing the government for damages. As a response, Aven and Renn comment that the authorities did not present risk in this way. Rather, the typical format was to ignore the risks related to potential side effects. Using a risk expression as above, the many relevant aspects of risk have been revealed, in a way which is considered rather balanced.

We know that many people have problems in understanding and acknowledging uncertainties: as long as there is a possibility, the event is considered bound to happen. We need better methods and processes that help people to gain a balanced perspective on risks, uncertainties and probabilities. Examples are needed from real life, showing that we live perfectly well with risks and uncertainties – for example in relation to traffic. We need to be crystal clear what a probability means, for example, when stating that there is a specific probability of the event occurring. The current nomenclature, as used in practice, is not good enough for effective communication. We rarely hear authority officials providing clear interpretations of probabilities. How can we then obtain successful communication with the public?

The main lesson for risk managers and regulators is that transparency and openness are essential for gaining trust and confidence. Sometimes, such openness is not well understood, and information may be taken by a special interest group to serve their specific interests and to mobilize public outrage. Withholding information, however, is not an adequate solution for avoiding this. On the contrary, if this strategy becomes known to the public, one can expect an explosion of outrage and accusations. Rather than trying to filter information, public authorities should concentrate on methods of how to best communicate risk information and how to engage stakeholders and the public in constructive risk management dialogues. Many risk communication guidebooks and public involvement manuals have been published that provide valuable guidance to the authorities. There seems, however, to be a reluctance to pursue this path and to follow this advice. With the exception of proprietary information and information that may damage public security (for example, strategies against terrorism), an open and transparent information policy is recommended.

See also the discussion in Section 8.2.