Chapter 2
Risk Governance: Contemporary and Future Challenges

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Abstract The chapter will develop a general concept for integrative risk governance emphasizing procedural and structural mechanisms as well as precaution-oriented considerations. Key terms used in this chapter refer to seriousness, complexity, scientific uncertainty and socio-political ambiguity; the application of precaution in risk handling; the handling of risk issues that are subject to strongly divergent cultural attitudes, political perspectives or economic interests; the quest for more openness and transparency during the entire risk handling process; and the design of effective means and institutional arrangements for stakeholder and public involvement. The integrative concept refers to a set of procedural elements, which first of all embraces the classic components of risk analysis: pre-assessment, appraisal, and management. A further phase, comprising the characterization and evaluation of risk, is placed between the appraisal and management phase. The risk process also includes risk communication as a component that is a necessary complement to all risk phases. The chapter will first introduce the key challenges: seriousness, complexity, uncertainty and ambiguity. Section 2.3 is devoted to the explanation of the IRGC risk governance model and its components: pre-assessment, appraisal, characterization and evaluation, management and communication. The main lessons from using the risk governance model are summarized in Sect. 2.4.

Keywords Complexity • Governance • REACH • Risk • Uncertainty

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2.1 Challenges Posed by Seriousness, Complexity, Uncertainty, and Ambiguity

2.1.1 Seriousness

Seriousness particularly refers to the inherent hazard potential of a risk agent to cause certainly and unambiguously significant harm to the environment or to human health (irrespective of exposure, dose–response relationships or intake quantity). This potential depends on special characteristics of the risk agent under investigation (Mueller-Herold et al. 2005). The new legislative framework on the regulation of chemicals of the European Union provides, for example, a number of specific exposure-based hazard criteria such as carcinogenicity, mutagenicity, toxicity for reproduction, and ecotoxicity, which are generally applicable to chemical threats and other areas as food safety.\(^1\) In analogy to REACH, the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) of the United Nations includes similar references to specific chemical hazards that could cause serious damage if released into the environment. Moreover, serious non-fatal health threats caused by endocrine disruptors, neurotoxins, immunotoxins or sensitising agents fall in this category. Additional criteria such as ubiquity, persistency, bio-accumulation, etc., help to qualify or even quantify the degree of hazard that is associated with a risk agent. Hazards may never materialize over time, if exposure is low or intake below the thresholds of causing any harm. These hazard characteristics may, however, be an excellent guide for setting up an early warning system, if effects are still unknown or ignorance about potential impacts prevails. The so-called ‘grasshopper effect’, i.e. repeated evaporation and condensation, causes an enhanced persistence and substance accumulation of persistent pollutants in the polar regions where they damage the Eskimo population and the ecosystem there. In other risk areas where there exist robust applicable data, seriousness may be formulated in terms of risk-based thresholds, such as concentrations for certain less hazardous toxicants.

2.1.2 Complexity

Complexity refers to the difficulty of identifying and quantifying causal links between a multitude of potential candidates and specific adverse effects (Renn and Walker 2007; Renn 2008). A crucial in this respect concerns the applicability of probabilistic risk assessment techniques. If the chain of events between a cause and an effect follows a linear relationship (as for example in car accidents, or in an

\(^1\)See the EU-Regulation No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) and establishing a European Chemicals Agency.
overdose of pharmaceutical products), simple statistical models are sufficient to calculate the probabilities of harm. Such simple relationships may still be associated with high uncertainty, for example, if only few data are available or the effect is stochastic by its own nature. Sophisticated models of probabilistic inferences are required if the relationship between cause and effects becomes more complex. The nature of this difficulty may be traced back to interactive effects among these candidates (synergisms and antagonisms, positive and negative feedback loops), long delay periods between cause and effect, inter-individual variation, intervening variables, and others. It is precisely these complexities that make sophisticated scientific investigations necessary since the dose–effect relationship is neither obvious nor directly observable. Nonlinear response functions may also result from feedback loops that constitute a complex web of intervening variables. Complexity requires therefore sensitivity to non-linear transitions as well as to scale (on different levels). It also needs to take into account a multitude of exposure pathways and the composite effects of other agents that are present in the exposure situation. Examples of highly complex risk include sophisticated chemical facilities, synergistic effects of potentially toxic substances, failure risk of large interconnected infrastructures and risks of critical loads to sensitive ecosystems.

### 2.1.3 Scientific Uncertainty

Uncertainty is different from complexity, but most often results from an incomplete or inadequate reduction of complexity in modelling cause–effect chains. Whether the world is inherently uncertain is a philosophical question that is not pursued here. It is essential to acknowledge in the context of risk assessment that human knowledge is always incomplete and selective, and, thus, contingent upon uncertain assumptions, assertions and predictions (Functowicz and Ravetz 1992; Laudan 1996; Renn 2008). It is obvious that the modelled probability distributions within a numerical relational system can only represent an approximation of the empirical relational system that helps elucidate and predict uncertain events. It therefore seems prudent to include additional aspects of uncertainty (van Asselt 2000; van der Sluijs et al. 2003). Although there is no consensus in the literature on the best means of disaggregating uncertainties, the following categories appear to be an appropriate means of distinguishing between the key components of uncertainty:

- **Variability** refers to different vulnerability of targets such as the divergence of individual responses to identical stimuli among individual targets within a relevant population such as humans, animals, plants, landscapes, etc.;
- **Inference** effects relate to systematic and random errors in modelling inducing problems of drawing extrapolations or logic deductions from small statistical samples, from animal data or experimental data onto humans or from large doses to small doses, etc. All of these are usually expressed through statistical confidence intervals;
• **Indeterminacy** results from genuine stochastic relationship between cause and effects, apparently non-causal or non-cyclical random events, or badly understood non-linear, chaotic relationships;
• **System** boundaries allude to uncertainties stemming from restricted models and the need for focusing on a limited amount of variables and parameters;
• **Ignorance** means the lack of knowledge about the probability of occurrence of a damaging event and about its possible consequences.

The first two components of uncertainty qualify as epistemic uncertainty and, therefore, can be reduced by improving existing knowledge and advancing current modelling tools. The last three components are genuine uncertainty components and can be characterized, to some extent, by using scientific approaches, but cannot be completely resolved. The validity of the end results is questionable and, for risk management purposes, additional information is needed, such as a subjective confidence level in risk estimates, potential alternative pathways of cause–effect relationships, ranges of reasonable estimates, loss scenarios and others. Examples of high uncertainty include many natural disasters, such as earthquakes, possible health effects of mass pollutants below the threshold of statistical significance, acts of violence – such as terrorism and sabotage – and long-term effects of introducing genetically modified species into the natural environment.

### 2.1.4 Interpretative and Normative Ambiguity

**Interpretative and normative ambiguity** relates to divergent or contested perspectives on the justification, severity or wider ‘meanings’ associated with a given threat (Stirling 2003; Renn 2008). **Interpretative ambiguity** denotes the variability of (legitimate) interpretations based on identical observations or data assessments results, e.g. an adverse or non-adverse effect. Variability of interpretation, however, is not restricted to expert dissent. Laypeople’s perception of risk often differs from expert judgments because it is also a response to qualitative risk characteristics such as familiarity, personal or institutional control, assignment of blame, and others. Moreover, in contemporary pluralist societies diversity of risk perspectives within and between social groups is generally fostered by divergent value preferences, variations in interests and very few, if any universally applicable moral principles; all the more, if risk problems are complex and uncertain. That leads us to the aspect of **normative ambiguity**. It alludes to different concepts of what can be regarded as tolerable referring e.g. to ethics, quality of life parameters, distribution of risks and benefits, etc. A condition of ambiguity emerges where the problem lies in agreeing on the appropriate values, priorities, assumptions, or boundaries to be applied to the definition of possible outcomes. Examples for high interpretative ambiguity include low dose radiation (ionizing and non-ionizing), low concentrations of genotoxic substances, food supplements and hormone treatment of cattle. Normative ambiguities can be associated, for example, with passive smoking, nuclear power, pre-natal genetic screening and genetically modified food.
Most risks are characterized by a mixture of complexity, uncertainty and ambiguity. Passive smoking may be a good example of low complexity and uncertainty, but high ambiguity. Nuclear energy may be a good candidate for high complexity and high ambiguity, but relatively little uncertainty. Endocrine disrupters could be cited as examples for high complexity, uncertainty and ambiguity.

### 2.2 Conceptual Design of an Integrative Risk Governance Model

The risk governance concept\(^2\) that we propose consists of four consecutive phases (IRGC 2005):

- Pre-assessment
- Appraisal
- Characterization/evaluation
- Management

Risk communication accompanies all four phases. Each phase specifies activities that constitute important elements for good governance. This simple concept is in line with almost all other competing concepts and ensures the compatibility with professional codices and risk governance legislation. Moreover, it has transformed the linear structure more commonly found in other contemporary conceptions of risk governance into an open, cyclical, iterative and interlinked process, as shown in Fig. 2.1.

The four phases correspond to the two major challenges of risk governance: generating and collecting knowledge about the risk, and making decisions about how to mitigate, control or otherwise manage it. These two challenges are illustrated by the two activities portrayed on the horizontal axis: appraisal and management. However, there are two additional phases in which knowledge and values are closely intertwined: pre-assessment and characterization/evaluation. These two phases are located on the vertical axis and constitute interfaces between knowledge and values.

During the phase of pre-assessment, the problem is framed and defined, and the terms of reference are specified. This task needs to be governed by societal values (stating the goals, objectives and contextual conditions) and inspired by what we already know about the hazard (suspected impacts, exposure, persistence and others) (Zinn and Taylor-Gooby 2006). Similarly, when looking at all the evidence collected and condensed in the phase of characterization/tolerability judgement, a good understanding of this evidence, as well as a prudent judgement competence for making the necessary trade-offs between risk, benefits and other important impact categories, is

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\(^2\)The following concept of integrative risk governance collects, condenses and re-interprets different ideas, modules, project results, and publications on which the authors have worked on over the last decade. See e.g. WBGU (2000); Klinke and Renn (1999, 2002); Klinke et al. (2006); IRGC (2005); Renn and Walker (2007); Renn (2008).
Fig. 2.1 IRGC Risk Governance Framework – general model (Source: IRGC 2005: 13)
essential for an effective governance process. This design of the four phases avoids the naive separation of facts here and values there, but also escapes the solipsism of post-modern relativity by honouring the analytical distinctions between the factual world and the world of values even if they clearly interact.

### 2.2.1 Pre-assessment

Risks are mental constructions, which are not real phenomena but the result of perceptions and/or interpretations by humans (Krohn and Krücken 1993; OECD 2003). The introduction of risk as a mental construct is contingent on the presumption that human action can prevent harm in advance. Risk as a mental construct has major implications on how risk is considered. Risks are created and selected by human actors. What counts as a risk to someone may be an act of God to someone else or even an opportunity for a third party. Although societies have over time gained experience and collective knowledge of the potential impacts of events and activities, one cannot anticipate all potential scenarios and be worried about all the many potential consequences of a proposed activity or an expected event. By the same token, it is impossible to include all possible options for intervention. Therefore societies have been selective in what they have chosen to be worth considering and what to ignore (Beck 1994). Specialized organisations have been established to monitor the environment for hints of future problems and to provide early warning of some potential future harm. This selection process is not arbitrary. It is guided by cultural values, by institutional and financial resources, and by systematic reasoning.

A systematic review of risk-related actions needs to start with an analysis of what major political and societal actors such as e.g. governments, companies, the scientific community and the general public select as risks and what types of problems they label as risk problems (rather than opportunities or innovation potentials, etc.). In technical terms this is called framing and encompasses the selection and interpretation of phenomena as relevant risk topics (Tversky and Kahneman 1981; van der Sluijs et al. 2003). The process of framing is mostly already part of the governance structure since governmental authorities (national, supranational and international agencies), risk and opportunity producers (e.g. industry), those affected by risks and opportunities (e.g. consumer organizations) and interested bystanders (e.g. the media or an intellectual elite) are involved and often in conflict with each other when framing the issue. What counts as risk may vary among these actor groups. Whether a consensus evolves about what requires consideration as a relevant risk depends on the legitimacy of the selection rule. The acceptance of selection rules rests on two conditions: (1) All actors need to agree with the underlying goal (often legally prescribed such as the threshold or maximum loading of specific chemicals in a water body); (2) They need to agree with the implications derived from the present state of knowledge (whether and to what degree the identified hazard impacts the desired goal).
2.2.2  Risk Appraisal

For politics and society to come to reasonable decisions about risks in public interest, it is not enough to consider only the results of (scientific) risk assessment. In order to understand the concerns of people affected and various stakeholders, information about both risk perceptions and the further implications of the direct consequences of a risk is needed and should be taken into account by risk management.\(^3\)

Risk appraisal thus includes the scientific assessment of the risks to human health and the environment and an assessment of related concerns as well as social and economic implications (Renn and Walker 2007). The appraisal process should be clearly dominated by scientific analyses – but, in contrast to traditional risk regulation models, the scientific process includes both the natural/technical as well as the social sciences, including economics. The risk appraisal comprises two stages:

1. Risk assessment: experts of natural and technical sciences produce the best estimate of the physical harm that a risk source may induce.
2. Concern assessment: experts of social sciences including economics identify and analyze the issues that individuals or society as a whole link to a certain risk. For this purpose the repertoire of the social sciences such as survey methods, focus groups, econometric analysis, macro-economic modelling, or structured hearings with stakeholders may be used.

There are different approaches and proposals how to address the issue of risk appraisal. The German Advisory Council on Global Change (WBGU) has developed a set of eight criteria to characterize risks beyond the established assessment criteria (WBGU 2000; Klinke and Renn 2002). Some of the criteria have been used by different risk agencies or risk appraisal processes.

- **Extent of damage**: Adverse effects in natural units, e.g. death, injury, production loss, etc.
- **Probability of occurrence**: Estimate of relative frequency, which can be discrete or continuous.
- **Incertitude**: How do we take account of uncertainty in knowledge, in modelling of complex systems or in predictability in assessing a risk?
- **Ubiquity**: Geographical dispersion of damage.
- **Persistence**: How long will the damage last?
- **Reversibility**: Can the damage be reversed?
- **Delay effects**: Latency between initial event and actual damage.
- **Potential for mobilisation**: The broad social impact. Will the risk generate social conflict or outrage, etc.?

- **Inequity and injustice** associated with the distribution of risks and benefits over time, space and social status.

\(^3\)This includes the social mobilization potential, i.e. how likely is it that the risk consequences generate social conflicts and psychological reactions by individuals or groups?
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- **Psychological stress and discomfort** associated with the risk or the risk source (as measured by psychometric scales).
- **Potential for social conflict and mobilisation** (degree of political or public pressure on risk regulatory agencies).
- **Spill-over effects** that are likely to be expected when highly symbolic losses have repercussions on other fields such as financial markets or loss of credibility in management institutions.

These four sub-criteria of the last category reflect many factors that have been proven to influence risk perception. The ‘appraisal guidance’ published by the UK Treasury Department in 2005 recommends a risk appraisal procedure that is similar to our proposal and includes as well both the results of risk assessment and the direct input from data on public perception and the assessment of social concerns (HM Treasury 2005).

### 2.2.3 Tolerability and Acceptability Judgment

Delineating and reasoning a judgment about the tolerability or acceptability of a given risk is one of the most controversial activities in the risk governance process. The term ‘tolerable’ refers to an activity that is seen as worth pursuing (for the benefit it carries) yet it requires additional efforts for risk reduction within reasonable limits. The term ‘acceptable’ refers to an activity where the remaining risks are so low that additional efforts for risk reduction are not seen as necessary. Judging risks according to their tolerability and acceptability leads to the well-proven means of the traffic light model in form of a risk diagram with probabilities on the $y$-axis and extent of consequences on the $x$-axis (Fig. 2.2). In this variant of the model the red zone signifies intolerable risk, the yellow one indicates tolerable risk in need of further management actions and the green zone shows acceptable or even negligible risk.

To draw the line between ‘intolerable’ and ‘tolerable’ as well as ‘tolerable’ and ‘acceptable’ is one of the most difficult tasks of risk governance. The UK Health and Safety Executive developed a procedure for chemical risks based on risk–risk comparisons (Löfstedt 1997). Some Swiss cantons such as Basle County experimented with Round Tables as a means to reach consensus on drawing the two lines, whereby participants in the Round Table represented industry, administrators, county officials, environmentalists, and neighbourhood groups. Irrespective of the selected means to support this task, the judgement on acceptability or tolerability is contingent on making use of a variety of different knowledge sources. One needs to include the risk estimates derived from the risk assessment stage, and additional assessment data from the concern assessment within the appraisal stage.

Judgments on acceptability rely on two major inputs: values and evidence. What society is supposed to tolerate or accept can never be derived from looking at the evidence alone. Likewise, evidence is essential if we are to know whether a value has been violated or not (or to what degree). With respect to values and evidence we can distinguish three cases.
Interpretative ambiguity means that evidence is seen as ambiguous but not on values. In those cases where there is unanimous agreement about the underlying values and even the threshold of what is regarded as tolerable or acceptable, evidence in the form of risk estimates may be sufficient to locate the risk within the traffic light diagram. A judgement can then best be made by those who have most expertise in risk and concern assessments, in which case it makes sense to place this task within the domain of risk appraisal.

Normative ambiguity refers to the ambiguity on values but not on evidence. If the underlying values of what could be interpreted as tolerable or acceptable are disputed, while the evidence of what is at stake is clearly given and non-controversial, the judgement needs to be based on a discourse about values and their implications. Such a discourse should be part of risk management. In these cases, science is very familiar with the risks and there is little uncertainty and interpretative ambiguity about dose–effect relationships. Yet there is considerable debate whether the application is tolerable or not. One example may be the use of phthalates in toys. All analysts are aware that the substance is potentially carcinogenic, but given the known exposure and the dose–response functions there is hardly any possibility for young children to be negatively affected. Yet the mere idea of having a carcinogenic substance in children’s’ toys has incited a fierce debate about the tolerability of such an ingredient in rubber toys.

Interpretative and normative ambiguity addresses a third case where both the evidence and the values are controversial. This would imply that assessment should engage in an activity to find some common ground for characterising and qualifying the evidence and risk management needs to establish agreement about the appropriate values and their application. A good example for this third case may be the interpretative and normative implications of global climate change. The Intergovernmental
Panel on Climate Change (IPCC) has gone through considerable efforts to articulate a common characterisation of climatic risks and their uncertainties. Given the remaining uncertainties and the complexities of the causal relationships between greenhouse gases and climate change, it is then a question of values whether governments place their priorities on prevention or on mitigation (Keeney and McDanels 2001). To deal with similar issues regarding chemical pollution, efforts are in progress to initiate an International Panel on Chemical Pollution (IPCP).

Since the last case includes both issues of the other two, the process of judging the tolerability and acceptability of a risk can be structured into two distinct components: risk characterisation and risk evaluation. The first step, risk characterisation, determines the evidence-based component for making the necessary judgement on the tolerability and/or acceptability of a risk; the step risk evaluation determines the value-based component for making this judgement.

The separation of evidence and values underlying the distinction between characterisation and evaluation is, of course, functional and not necessarily organisational. Since risk characterisation and evaluation are closely linked and each depends on the other, it may even be wise to perform these two steps simultaneously in a joint effort by both risk assessment and risk management. The US regulatory system tends to favour an organisational combination of characterisation and evaluation, while European risk management tends to maintain the organisational separation, e.g. in the food area (Löfstedt and Vogel 2001). The same is true for chemical regulation. ECHA, the European Chemical Agency, has the mandate to assess and characterize risks from chemical substances with the REACH regime. The management part of issuing regulation is left to the EU Commission.

### 2.2.4 Risk Management

Risk management reviews the information and findings from risk appraisal (risk assessment and concern assessment) and the results and conclusions from tolerability and acceptability judgment (risk characterization and evaluation), in order to assess, evaluate and select appropriate risk management options. Starting point for risk management are three potential outcomes:

- In an intolerable situation the risk source such as a chemical or a technology needs to be refused or substituted.

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4For the IPCP see the website http://www.ipcp.ch.

5An example for an institutionalized body to fulfil at least partially tasks and functions of tolerability and acceptability assessment and risk appraisal on the national level is the UK Chemical Stakeholder Forum. The forum consists of stakeholders from different associations such as chemical industry, business, environment, consumer protection as well as research institutes. They gather different perceptions and concerns, evaluate and prioritize different chemicals and propose risk management strategies in order to deliberate the government.
In a tolerable situation the risks need to be reduced or handled in some other way within the limits of reasonable resource investments (ALARP, including best practice).\textsuperscript{6}

In an acceptable situation the risks are so minor – perhaps even regarded as negligible – that any risk reduction effort is unnecessary. However, risk sharing via insurances and/or further risk reduction on a voluntary basis presents options for action which can be worthwhile pursuing even in the case of an acceptable risk.

With regard to these outcomes risk management may either face a situation of unanimity, i.e. all relevant actors agree with how a given risk situation should be qualified, or a situation of conflict in which major actors challenge the classification undertaken by others. The degree of controversy is one of the drivers for selecting the appropriate instruments for risk prevention or risk reduction.

If risks are classified as tolerable, or if there is dispute as to whether they are tolerable or acceptable, risk management needs to design and implement actions that make these risks acceptable over time. Should this not be feasible then risk management, assisted by communication, needs at least to credibly convey the message that major effort is undertaken to bring these risks closer to being acceptable. This task can be described in terms of classic decision theory (Morgan 1990; Hammond et al. 1999).

The decision making process of risk management starts with identifying and generating risk management options. Generic risk management options include risk avoidance, risk reduction, risk transfer and possibly self retention. Whereas to avoid a risk means either selecting a path which does not touch on the risk (e.g. by abandoning the development of a specific chemical or technology) or taking action in order to fully eliminate a certain risk, risk transfer deals with ways of passing the risk on to a third party. Self retention as a management option essentially means taking an informed decision to do nothing about the risk and to take full responsibility both for the decision and any consequences occurring thereafter. Risk management by means of risk reduction can be accomplished by many different means such as:

- Technical standards and limits that prescribe the permissible threshold of concentrations, emissions, take-up or other measures of exposure
- Performance standards for chemical and technological processes such as minimum temperatures in waste incinerators
- Technical prescriptions referring to the blockage of exposure (e.g. via protective clothing) or the improvement of resilience (e.g. via immunisation or more indestructible constructions)
- Governmental economic incentives including taxation, duties, subsidies and certification schemes
- Third party incentives, i.e. private monetary or in kind incentives

\textsuperscript{6}This can be addressed by private actors (such as corporate risk managers) or public actors (such as regulatory agencies) or both (public-private partnerships).
• Compensation schemes (monetary or in kind)
• Insurance and liability
• Co-operative and informative options ranging from voluntary agreements to labelling and education programs

All these options can be used individually or in combination to accomplish even more effective risk reduction. Options for risk reduction can be initiated by private and public actors or both together.

Afterwards the decision making unit assesses the risk management options with respect to predefined criteria. Each of the options will have desired and unintended consequences which relate to the risks that they are supposed to reduce. In most instances, an assessment should be done according to the following criteria:

• **Effectiveness**: Does the option achieve the desired effect?
• **Efficiency**: Does the option achieve the desired effect with the least resource consumption?
• **Minimisation of external side effects**: Does the option infringe on other valuable goods, benefits or services such as competitiveness, public health, environmental quality, social cohesion, etc.? Does it impair the efficiency and acceptance of the governance system itself?
• **Sustainability**: Does the option contribute to the overall goal of sustainability? Does it assist in sustaining vital ecological functions, economic prosperity and social cohesion?
• **Fairness**: Does the option burden the subjects of regulation in a fair and equitable manner?
• **Political and legal implementability**: Is the option compatible with legal requirements and the political culture?
• **Ethical acceptability**: Is the option morally acceptable?
• **Public acceptance**: Will the option be accepted by those individuals who are affected by it? Are there cultural preferences or symbolic connotations that have a strong influence on how the risks are perceived?

Measuring management options against these criteria may create conflicting messages and results. Many measures that prove to be effective may turn out to be inefficient or unfair to those who will be burdened. Other measures may be sustainable but not accepted by the public or important stakeholders. These problems are aggravated when dealing with global risks. What appears to be efficient in one country may not work at all in another country. Risk management is therefore well advised to make use of the many excellent guidance documents on how to handle risk trade-offs and how to employ decision analytic tools for dealing with conflicting evidence and values (Wiener 1998; van der Sluijs et al. 2003).

Subsequently, risk management evaluates the risk management options, which is similar to risk evaluation since this step integrates the evidence on how the options perform with regard to the evaluation criteria with a value judgement about the relative weight each criterion should be assigned. Ideally, the evidence should come from experts and the relative weights from politically legitimate decision makers.
In practical risk management, the evaluation of options is done in close cooperation between experts and decision makers. As pointed out later, this is the step in which direct stakeholder involvement and public participation is particularly important and is therefore best assured by making use of a variety of methods (Rowe and Frewer 2000; OECD 2002; Renn 2008).

The final step in the decision making process should be the selection of risk management options. Once the different options are evaluated, a decision has to be made as to which options are selected and which rejected. This decision is obvious if one or more options turn out to be dominant (relatively better on all criteria). Otherwise, trade-offs have to be made that need legitimisation (Graham and Wiener 1995). A legitimate decision can be made on the basis of formal balancing tools (such as cost–benefit or multi-criteria-decision analysis), by the respective decision makers (given his decision is informed by a holistic view of the problem) or in conjunction with participatory procedures.

It is also the task of risk management to oversee and control the implementation process. In many instances implementation is delegated, as when governments take decisions but leave their implementation to other public or private bodies or to the general public. However, the risk management has at any rate the implicit mandate to supervise the implementation process or at least monitor its outcome.

2.2.5  **Risk Communication**

Given the arguments about risk perception and stakeholder involvement, it is essential to have an effective communication at the core of any successful activity to assess and manage risks. The field of risk communication initially developed as a means of investigating how best expert assessments could be communicated to the public so that the tension between public perceptions and expert judgement could be bridged. In the course of time this original objective of educating the public about risks has been modified and even reversed as the professional risk community realized that most members of the public refused to become ‘educated’ by the experts but rather insisted that alternative positions and risk management practices should be selected by the professional community in their attempt to reduce and manage the risks of modern technology (Plough and Krimsy 1987).

Risk communication is needed throughout the whole risk handling chain, from the framing of the issue to the monitoring of risk management impacts. The precise form of communication needs to reflect the nature of the risks under consideration, their context and whether they arouse, or could arouse, societal concern. Communication has to be a means to both ensure that (Renn 2008):

- Those who are central to risk framing, risk appraisal or risk management understand what is happening, how they are to be involved, and, where appropriate, what their responsibilities are.
- Others outside the immediate risk appraisal or risk management process are informed and engaged.
The first task of risk communication, i.e. facilitating an exchange of information among risk professionals, has often been underestimated in the literature. A close communication link between risk/concern assessors and risk managers, particularly in the phases of pre-assessment and tolerability/acceptability judgement, is crucial for improving overall governance. Similarly, co-operation among natural and social scientists, close teamwork between legal and technical staff and continuous communication between policy makers and scientists are all important prerequisites for enhancing risk management performance. This is particularly important for the initial screening phase where the allocation of risks is performed.

The second task that of communicating risk appropriately to the outside world, is also a very challenging endeavour. Many representatives of stakeholder groups and, particularly, members of the affected and non-affected public are often unfamiliar with the approaches used to assess and manage risks and/or pursue a specific agenda, trying to achieve extensive consideration of their own viewpoints. They face difficulties when asked to differentiate between the potentially dangerous properties of a substance (hazards) and the risk estimates that depend on both the properties of the substance, the exposure to humans, and the scenario of its uses (Morgan et al. 2001). Also complicating communication is the fact that some risks are acute, with severe effects that are easy to recognize, whereas others exert adverse effects only weakly but over a long period of time. Yet other risks’ effects only start to show after an initial delay. Finally, it is no easy task to convey possible synergies of exposures to industrial substances with other factors that relate to lifestyle (e.g. nutrition, smoking, use of alcohol).

Effective communication, or the non-existence thereof, has a major bearing on how well people are prepared to face and cope with risk. Limited knowledge of and involvement in the risk management process can lead to inappropriate behaviour in emergency or risk-bearing situations (for example, when handling contaminated food or water or dealing with unknown chemicals). There is also the risk of failed communication: consumers or product users may misread or misunderstand risk warnings or labels so that they may, through ignorance, expose themselves to a larger risk than necessary. This is particularly prevalent in countries with high rates of illiteracy and unfamiliarity with risk-related terms. Providing understandable information to help people cope with risks and disasters is, however, only one function of risk communication. Most risk communication analysts list four major functions (Klinke and Renn 1999; OECD 2002):

- **Education and enlightenment**: inform the audience about risks and the handling of these risks, including risk and concern assessment and management.
- **Risk training and inducement of behavioural changes**: help people cope with risks and potential disasters.
- **Creation of confidence in institutions responsible for the assessment and management of risk**: give people the assurance that the existing risk governance structures are capable of handling risks in an effective, efficient, fair and acceptable manner (such credibility is crucial in situations in which there is a lack of personal experience and people depend on neutral and disinterested information). It should be kept in mind, however, that trust cannot be produced or generated,
but only be accumulated by performance, and that it can be undermined by the lack of respect for an individual within such an institution.

- **Involvement in risk-related decisions and conflict resolution:** give stakeholders and representatives of the public the opportunity to participate in the risk appraisal and management efforts and/or be included in the resolution of conflicts about risks and appropriate risk management options.

Although risk communication implies a stronger role for risk professionals to provide information to the public rather than vice versa, it should be regarded as a mutual learning process. Concerns, perceptions and experiential knowledge of the targeted audience(s) should thus guide risk professionals in their selection of topics and subjects: it is not the task of the communicators to decide what people need to know but to respond to the questions of what people want to know (‘right to know’ concept, see Baram 1984). Risk communication requires professional performance both by risk and communication experts. Scientists, communication specialists and regulators are encouraged to take a much more prominent role in risk communication, because effective risk communication can make a strong contribution to the success of a comprehensive and responsible risk management.

### 2.3 Conclusions

The starting point of this chapter was the insight that modern societies are in urgent need for a new inclusive and integrative framework promising to promote good risk governance, establish a more stringent approach to deal with serious, complex, uncertain and ambiguous risks, develop a more suited structure to cope with emerging systemic and global threats and provide a convincing and acceptable format for involving civil society in the decision-making process. Good governance seems to rest on the three components: knowledge, legally prescribed procedures and social values. It has to reflect specific functions, from early warning (radar function), via new assessment and management tools to improved methods of balanced risk evaluation, effective risk communication and deliberative participation. Criteria of good governance have been discussed in many different contexts. They need to be transferred to risk-related issues and put into operation so that best practices can be identified and recommended. Central items to be addressed are sound scientific expertise, adequate inclusion of public concerns, consistency and coherence in making trade-offs between risks and benefits, non-discrimination and proportionality in designing management options and assurance of thorough monitoring and independent oversight during implementation of management options. In addition, governance structures should reflect criteria such as transparency; effectiveness and efficiency; accountability; strategic focus; sustainability; equity and fairness; respect for the rule of law; and the need for the chosen solution to be politically and legally feasible, as well as ethically and publicly acceptable. Beyond the involvement of organized groups, the required framework needs to include procedures for general public participation and public dialogue and effective communication about risk issues.
In the modern pluralist world, most risks will need to be subject to such a robust governance approach if they are to be adequately managed.

Together with specialists and practitioners from different fields of risk analysis, we have tried to develop such a framework (Klinke and Renn 2002; IRGC 2005; Klinke et al. 2006; Renn and Walker 2007; Renn 2008). Drawing on an analysis of a selection of well-established approaches to what has traditionally been called ‘risk analysis’ or ‘risk management’, the new risk governance framework introduced in this chapter has been designed to offer both a comprehensive means of integrating risk identification, assessment, management and communication, and a tool that can compensate the absence of (or a weaknesses in) risk governance structures and processes (Bunting et al. 2007). Use of the framework promises to identify the key steps in the risk governance process, and the diagnosis of potential deficits, problems or shortcomings in governance institutions or procedures. In addition, it can assist in facilitating a thorough understanding of risk issues, identifying the stakeholders interested in (and concerned with) the risks and providing guidance for how, and when, to include stakeholders in the process.

What are the innovative features of the framework and how does it differ from those that were analysed in this volume?

The risk governance process is understood to include, but also to go beyond, the three conventionally recognized elements of risk analysis (risk assessment, risk management and risk communication). Governance thus includes matters of institutional design, technical methodology, administrative consultation, legislative procedure and political accountability on the part of public bodies, and social or corporate responsibility on the part of private enterprises. But it also includes more general provision on the part of government and commercial and civil society actors for building and using scientific knowledge, for fostering innovation and technical competences, for developing and refining competitive strategies, and for promoting social and organizational learning.

The framework builds upon the logical structure of four consecutive phases called pre-assessment, appraisal, characterization/evaluation and management. In addition, risk communication accompanies all four phases. Within each of the boxes, specific activities are listed that are deemed essential for meeting the requirements of good governance. The framework offers a truly interdisciplinary and multilevel governance approach. Most notably, it urges risk governance institutions to elicit not only knowledge about the physical impacts of technologies, natural events or human activities, but also knowledge about the concerns that people associate with this cause of risks. This concern assessment should not be confused with eliciting stakeholder feedback or providing platforms for participatory processes. It is, rather, a social science activity aimed at providing sound insights and a comprehensive diagnosis of concerns, expectations and worries that individuals, groups or different cultures may associate with the hazard or the cause of the hazard (Hyman and Stiftel 1988). This social science analysis should be submitted to the same kind of methodological scrutiny and peer review as any other natural science activity.

Parallel to this concern assessment, the framework provides input on all governance levels from stakeholders either by contributing additional knowledge or by inserting their values, interests and preferences into the evaluation of the risk itself.
and the selection of the most effective, efficient and fair set of management options. It promotes the idea of inclusive governance, which is seen as a necessary, although insufficient, prerequisite for tackling risks in both a sustainable and acceptable manner and, consequently, imposes an obligation to ensure the early and meaningful involvement of all stakeholders and, in particular, civil society (Jasanoff 1993).

How can the framework be used in the future? First, providing a unified, yet flexible, concept, it can assist risk researchers to conduct comparative analyses among and between different risk types, thus ensuring that resource distribution on risk management across risk sources and technologies follows a consistent and efficient pattern. Second, it may help risk governance institutions to structure their projects in line with the phases and components outlined in this volume. Third, the framework may be a worthwhile basis for diagnosing deficiencies in existing risk governance regimes around the world and may provide suggestions on how to improve them. These three functions are particularly pertinent to risk management for chemicals in order to develop the skills to harvest the benefits of chemical substances and processes as well as to master and limit the risks that are associated with their use.

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