

Coping with Complexity, Uncertainty and Ambiguity in Risk Governance: A Synthesis

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Abstract The term governance describes the multitude of actors and processes that lead to collectively binding decisions. The term risk governance translates the core principles of governance to the context of risk-related policy making. We aim to delineate some basic lessons from the insights of the other articles in this special issue for our understanding of risk governance. Risk governance provides a conceptual as well as normative basis for how to cope with uncertain, complex and/or ambiguous risks. We propose to synthesize the breadth of the articles in this special issue by suggesting some changes to the risk governance framework proposed by the International Risk Governance Council (IRGC) and adding some insights to its analytical and normative implications.

Keywords Ambiguity · Communication · Complexity · Risk governance · Science–policy interface · Uncertainty

INTRODUCTION

Risk governance denotes both the institutional structure and the policy process that guide and restrain collective activities of a group, society or international community to regulate, reduce or control risk problems. The contemporary handling of collectively relevant risk problems has been shifted from traditional state-centric approaches with hierarchically organized governmental agencies as the dominant locus of power to multi-level governance systems, in which the political authority for handling risk problems is distributed to separately constituted public bodies (cf. Rosenau 1992; Lidskog 2008; Lidskog et al. 2011). These bodies are characterized by overlapping jurisdictions that do not match the traditional hierarchical order (cf. Skelcher 2005) and multi-actor alliances that

include traditional governmental actors such as the executive, legislative and judicial branch, but also socially relevant actors from civil society, most notably industry, science and non-governmental organizations (NGOs). This implicates an increasingly multilayered and diversified socio-political landscape in which a multitude of actors, their perceptions and evaluations draw on a diversity of knowledge and evidence claims, value commitments and political interests in order to influence processes of risk analysis, decision-making, and risk management (Irwin 2008).

Institutional diversity can offer considerable advantages when complex, uncertain and ambiguous risk problems need to be addressed because, first, risk problems with different scopes can be managed at different levels, second, an inherent degree of overlap and redundancy makes non-hierarchical adaptive and integrative risk governance systems more resilient and therefore less vulnerable, and third, the larger number of actors facilitates experimentation and learning (Renn 2008; Klinke and Renn in press). Disadvantages refer to the possible commodification of risk; the fragmentation of the risk governance process; costly collective risk decision-making; the potential loss of democratic accountability and paralysis by analysis, i.e., the inability to make decisions due to unresolved cognitive and normative conflicts and lack of accountability vis-a-vis multiple responsibilities and duties (Lyall and Tait 2004; Garrelts and Lange 2011).

Thus, understanding the dynamics, structures, and functionality of risk governance processes requires a general and comprehensive understanding of procedural mechanisms and structural configurations. The classic model of risk analysis consisting of three components: risk assessment, management, and communication proves to be too narrowly focused on private or public regulatory bodies

as to be capable of covering the variety of actors and processes in governing risk. This has been echoed by all the papers in this special issue. Gilek et al. (2011) pointed out that complex problems such as those of the Baltic Sea need a more sophisticated and, in particular, iterative approach to risk analysis and management. Hammer et al. (2011) emphasized the need for a multi-level governance system, which is capable of integrating top-down and bottom-up approaches. Linke et al. (2011) highlighted the importance of evaluation of risk as a separate phase in the risk governance process while Jönsson (2011) illustrated the crucial function of framing for gaining a better understanding of the media discourse about risk. All these analyses and case studies underline the need to enrich the classic risk governance model by adding two additional stages dealing with risk characterization/evaluation and pre-assessment (or framing) (IRGC 2005; Renn 2008). These stages will be explained later in the paper.

Furthermore, risk governance incorporates expert, stakeholder, and public involvement as a core feature in the stage of communication and deliberation. The reliance on expanded inclusion of stakeholders in the risk governance process was the central theme of the contributions by Lidskog et al. (2011) as well as by Karlsson et al. (2011). In spite of new attempts to develop new models and frameworks of risk governance, there is still a need for linking these conceptual frameworks to actual case studies and to explore their usefulness for designing more informed and robust risk management strategies (Renn and Walker 2008). As Assmuth (2011) concluded in his article: “With complex risk and risk–benefit issues such as those of Baltic Sea fish, a narrow and rigid assessment and management approach based on illusory certainty and on a sectorized and top-down governance and deliberation style needs to be complemented by a broader, more flexible and evolutionary approach”.

The collection of papers in this special issue provides an excellent opportunity to revisit the risk governance literature and draw some conclusions about the essential components of risk governance. This is done along the five stages of governance that have been proposed by the International Risk Governance Council in Geneva (IRGC 2005, 2007). We have selected this framework as our analytic starting point partly because several of the papers in this special issue refer to this framework or even apply it to their line of arguments partly because we have used this framework in a multitude of publications (Klinke and Renn 2002, in press; Renn 2008; van Asselt and Renn, in press).

The main objective of this paper is to summarize and interpret the major insights coming from the papers in this special issue using the IRGC framework as a guiding principle. Based on these reflections and similar investigations in the literature, we will suggest some changes and

modifications to the original IRGC framework. For this purpose we will first describe and explore the terms governance and risk, then outline three major characteristics of risk that pose specific challenges for risk governance and entail particular forms of involvement of actor groups. Subsequently, we address each stage of the risk governance process: pre-assessment, interdisciplinary risk estimation, characterization and evaluation, management and communication/participation. Furthermore, we will explicate the design of risk communication and participation in order to cope with the challenges raised by the three risk characteristics. Finally, the article concludes with some basic lessons for risk governance.

FROM GOVERNMENT TO GOVERNANCE

The term governance has been broadly defined in the social sciences as the informal and formal processes and institutions that guide and restrain the collective activities of a group (Keohane and Nye 2000). Governing choices in modern societies are generally conceptualized as a mutual interplay between governmental institutions, economic forces and civil-societal interests (mediated by, e.g., NGOs). Generally speaking, governance embodies a non-hierarchically organized structure encompassing state and non-state actors bringing about collectively binding policies without superior authority (cf. Rosenau 1992; Lidskog 2008). In this perspective, non-state actors play an increasingly relevant role due to their decisive advantages of information and resources compared to governmental agencies (Kern and Bulkeley 2009).

The notion governance came into fashion in the 1980s in circles engaged with development and was soon adopted in other domains. During the last decade, the term has experienced tremendous popularity in the literature in the fields of, among others, international relations, various policy sciences (among others in subfields referred to as European studies and comparative political science), environmental studies and risk research. The idea of governance has been (re-)introduced¹ to enlarge the perspective on policy, politics, and policies by acknowledging that government is not the only actor² in managing and organizing societal and

¹ The etymology of the term dates back to the Ancient Greek times (Kjaer 2004; Halachmi 2005). Plato used the term “kuberman” as a reference to leadership, which assimilated in Latin to “gubernare”. This notion evaluated along various trajectories. Next to English, it is part of, among others, the French, Spanish and Portuguese vocabulary.

² The possible range of governance has been often termed provocatively as “Governance by government”, “governance with government” and “governance without government” (Rosenau 1992, 1995), which emphasizes the decreasing role of the nation state.

political solutions. The shift to governance is best understood as response to new challenges, such as globalization, increased international cooperation (such as the European Union), societal changes, including the increased engagement of citizens and the rise of non-governmental organizations (NGOs), changing role of the private sector, an augmenting complexity of policy issues, and the resulting difficulty in taking decisions with confidence and legitimacy (Walls et al. 2005).

Many classical regulation theories share a hierarchic orientation with government as the central actor. In policy theories inspired by economics that central role is awarded to the market (political economy). Both clusters of theories are focused on a dominant actor in their perspective on power and control. That is different in the governance perspective. In that view, collective binding policy solutions are generated and implemented in complex multi-actor networks and processes. Power is distributed, as multi-actor networks involve a wide variety of actors. The governance perspective also considers various social actors next to state and market, including new civic actors, such as expert groups or NGOs and ad hoc coalitions of civilians, of which it is unclear who their supporters are and whom they represent. This view also includes the role of non-elected actors, such as civil servants, experts, think tanks and all kind of committees active in various ways in policy processes. The governance perspective thus draws attention to the diversity of actors, the diversity of their roles, their logic of action, the manifold relationships between them and all kind of dynamic networks emerging from these relationships. Scholars subscribing to the governance perspective examine actor-networks, the dynamics, and the roles of the various actors in these dynamics as a way to understand policy development and political decision making.

Some authors differentiate between horizontal and vertical governance (Benz and Eberlein 1999; Lyall and Tait 2004). The horizontal level includes relevant actors in decision making processes within a defined geographical, functional or political-administrative segment. The vertical level describes the links between these segments (such as the institutional relationships between the local, regional, state and international levels). When various levels are involved, which is often the case, the notion multi-level governance is advanced. In such a context, also “government” is no longer a single entity (Rauschmayer et al. 2009).

The notion governance is used both in a descriptive and in a normative sense. In a descriptive use of the term, the idea of a complex web of manifold interactions between heterogeneous actors is used to describe the current state of affairs pertaining to a particular policy domain. Governance is then an observation and describes an approach to

characterize the scale and scope of problem solving. The description of governance as “structures and processes for collective decision-making involving governmental and non-governmental actors” (Nye and Donahue 2000) is an example of a descriptive definition. In a normative use, the notion of governance refers to a model or framework for organizing and managing society. In the famous 2001 White Paper of the European Commission on governance, such a normative perspective on “good governance” is propagated. In the White Paper, which can be read as a response to the BSE-crisis, governance is presented as an alternative model, in which transparency, stakeholder participation, accountability and policy coherence are key principles.

The explanation of the term governance can also be transferred to the special term: “*risk governance*”. It involves the translation of the substance and core principles of governance to the context of risk and problem-solving (IRGC, International Risk Governance Council 2005; Klinke and Renn in press; Renn 2008; Renn and Walker 2008). It refers to a body of scholarly ideas on how to deal with demanding public risks. These ideas have been informed by 40 years of interdisciplinary research drawing from sociological and psychological research on risk, Science & Technology Studies (STS) and research by policy scientists and legal scholars (see reviews of literature in van Asselt and Renn in press; Fox et al. in press). This body of knowledge provides a convincing, theoretically demanding, and empirically sound basis to argue that many risks cannot be calculated on the basis of probability and effects alone, and that regulatory models which build on that assumption are not just inadequate, but constitute an obstacle to responsibly dealing with risk. In our view risk governance pertains to the various ways in which many actors, individuals and institutions, public and private, deal with risks surrounded by uncertainty, complexity and/or ambiguity³. It includes formal institutions and regimes and informal arrangements. It refers to the totality of actors, rules, conventions, processes, and mechanisms concerned with how relevant risk information is collected, analyzed, and communicated, and how regulatory decisions are taken (IRGC 2005, 2007; van Asselt 2007). However, risk governance is more than just a descriptive short hand for a complex, interacting network in which collective binding decisions are taken around a particular set of societal issues. The ambition is that risk governance similar to governance in general provides a conceptual as

³ With ambiguity, we refer to the plurality of legitimate viewpoints for evaluating decision outcomes and justifying judgements about their tolerability and acceptability. So ambiguity refers to the existence of multiple values and perspectives. The word “ambiguity” has different meanings in the English language. The term as it is used here was first coined in the 2005 IRGC risk governance framework.

well as normative basis for how to deal responsibly with uncertain, complex and/or ambiguous risks in particular (van Asselt and Renn in press).

All papers in this special issue echo the transition from risk management and risk government to a complex structure of a multi-actor and multi-criteria process for dealing with risks. Linke et al. (2011) as well as Rodin (2011) refer explicitly to the IRGC risk governance model. Other articles link their analysis to the theoretical framework of political regimes (Hassler 2011); multi-level governance (Assmuth 2011; Hammer et al. 2011) or a combination of complexity, uncertainty, and ambiguity (Assmuth 2011; Garrelts and Lange 2011; Karlsson et al. 2011; Pihlajamäki and Tynkkynen 2011). The papers also support the claim that risk policies emerge as a product of multiple players acting within multiple policy levels. This complex network makes it hard to understand the partial influence of each actor on the final outcome.

FROM SIMPLE TO SYSTEMIC RISKS

Central to risk governance is the recognition that there are various types of risk. Or as the Dutch Health Council phrased it back in 1995: “Not all risks are equal”. Since the economist Knight (1921) presented his definition of risk in the early twentieth century, risks have been treated in terms of probability and effects, dose and response, and agent and consequences. This dominant framing of risk is underlying what has been referred to as the technocratic, decisionistic, and economic models of risk assessment and management (cf. Millstone et al. 2004; Löfstedt 2005; Renn 2008). However, this framing of risk assumes that risks can be captured by a simple cause (or dose)-response model. For simple risks, the cause for the risk is indeed well known, the potential negative consequences are obvious, the uncertainty is low and there is hardly any ambiguity with regard to the interpretation of the risk. Simple risks are recurrent and not affected by ongoing or expected major changes. As a consequence, statistics are available and application of statistics to assess the risks in statistic terms is meaningful. Examples involve car accidents and regularly recurring natural events, such as seasonal flooding.

But many risks are not simple and cannot be calculated as a function of probability and effects. This view on risk, shared among an increasing group of risk scholars, explicitly challenges the idea of risk inherited from scholars as Knight (1921) in which the use of the notion of risk is restricted to numerically defined probability distributions (Aven and Renn 2009). Many risks are systemic (OECD 2003). The term “systemic” describes the extent to which a risk is embedded in the larger contexts of societal processes. Systemic risks requires a more holistic approach

to hazard identification, risk assessment, and risk management, because investigating systemic risks goes beyond the usual agent-consequence analysis. Instead, the analysis must focus on interdependencies and ripple and spill-over effects that initiate impact cascades between otherwise unrelated risk clusters (Hellstroem 2001). A well known example is BSE which had not only effects on the farming industry but also on the industry of animal feed, the economy as a whole and on politics (see; OECD 2003; Renn and Keil 2009). Systemic risks are not confined to national borders or a single sector, and do not fit the mono-causal model of risk. They are complex (multi-causal) and surrounded by uncertainty and/or ambiguity (Klinke and Renn 2002; Renn 2008). The notion of systemic risk is not applied in the articles of this special issue. However, the article on biodiversity loss (Johannesson et al. 2011) as well as that on eutrophication (Pihlajamäki and Tynkkynen 2011) include major elements of systemic risks. They describe the risks as being complex, uncertain, and fragile with the possibility of leading to a collapse of the ecosystem that would affect many sectors of society. In addition, the paper by Linke et al. (2011) refers several times to special features of systemic risks such trans-boundary ramifications and complex causal structures.

Systemic risks are characterized by a high degree of complexity, uncertainty, and ambiguity in addition of spreading out to other risk areas and risk arenas (OECD 2003). Complexity refers to the difficulty of identifying and quantifying causal links between a multitude of potential candidates and specific adverse effects (Renn 2008). If the chain of events between a cause and an effect follows a well-defined functional relationship (as for example in car accidents, or in an overdose of pharmaceutical products), simple statistical models are sufficient to calculate the probabilities of harm. Sophisticated models of probabilistic inferences are required if the relationship between cause and effects becomes more complex (Renn and Walker 2008). 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.

Scientific uncertainty relates to the limitedness or even absence of scientific knowledge (data, information) that makes it difficult to exactly assess the probability and possible outcomes of undesired effects (Aven and Renn 2009; Filar and Haurie 2010). It most often results from an incomplete or inadequate reduction of complexity in modeling cause-effect chains between a hazardous agent and its impact on a risk-absorbing target such as a building, an

ecosystem or a human being. 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; Renn 2008). It is obvious that the modeled probability distributions within a numerical relational system can only represent an approximation of the empirical relational system that helps elucidate and predict uncertain events.

Beyond being complex and uncertain systemic risks are also a cause of ambiguity. This means that there are different legitimate viewpoints from which to evaluate whether there are or could be adverse effects and whether these risks are tolerable or even acceptable. Therefore, ambiguity refers to the existence of multiple values. Risks are acceptable in case they are considered low or non-existing, so additional regulatory efforts are considered unnecessary. Activities are tolerable if they are considered as worth pursuing for the benefit that they carry (Bouder et al. 2007). In cases of tolerable risks, additional regulatory efforts for risk reduction or coping are welcomed. Actors, however, respond to risks according to their own risk constructs and images, yielding several meaningful and legitimate interpretations of risk assessment outcomes (Keeney 2004). Consider nuclear power: there as many deeply convinced supporters as they are opponents to the use of nuclear power based on differences in values (Fig. 1). As a consequence, whether risks are acceptable, tolerable or not could be

subject of considerable debate and intense controversy. Ambiguity is used to refer to such social situations around risk issues. Ambiguity results from divergent and contested perspectives on the justification, severity or wider meanings associated with a perceived threat (Stirling 2003). As a consequence, views differ on the ways to assess and appraise the risks, and more in particular on the relevance, meaning and implications of available risk information and on which management actions should be considered.

A typical case of ambiguity has been described in the paper by Pihlajamäki and Tynkkynen (2011). They demonstrate that ambiguity is key to understanding the responses of policy makers to the eutrophication problem in the Baltic Sea. They also stress the importance of different pools of knowledge as a means to understand and, ultimately, resolve ambiguity.

The classification of risk in the categories of complexity, uncertainty and ambiguity is not a trivial task. Some risks look simple in the beginning of an analysis and turn out to be more sophisticated, uncertain, and often ambiguous than originally thought. For this reasons Dreyer et al. (2009) have suggested to have a group of interdisciplinary experts (including the social sciences), stakeholders, and risk managers make these judgments in the beginning of the assessment process and revisit this judgment during the process, in particular during the phase of evaluation. Furthermore, using the classification in several IRGC workshops in which topics such as biofuel, nanotechnology, and food risks were discussed the participants reached an

Fig. 1 The anti-nuclear protest is a typical example of ambiguity about the acceptability of one option for electricity generation (Photo by Ortwin Renn)



agreement about the degree of complexity, uncertainty and ambiguity in a relatively short time (Renn and Walker 2008). We are therefore confident that the classification is not only theoretically sound but also practically feasible.

We would like to argue that uncertainty, complexity, and ambiguity point to different reasons why many risks defy simple concepts of causation. Our ability to understand risk ranges from putatively certain, simple, and clear to the totally uncertain, complex, and ambiguous (Rosa 2003). Consequently, simple risks should be treated as the special case, in which uncertainty, complexity and ambiguity are low (WRR 2009). Each of the three characteristics of risks contributes to a better understanding of the situation in which systemic risks emerge and manifest themselves.

Risk governance highlights the importance of uncertain⁴, complex and/or ambiguous risks. However, it is a consistent finding that in most of these cases, the risks are treated, assessed and managed as if they were simple. The assessment and management routines in place do not do justice to the nature of such risks. The consequences of this maltreatment ranges from social amplification or irresponsible attenuation of the risk, sustained controversy, deadlocks, legitimacy problems, unintelligible decision-making, trade conflicts, border conflicts, expensive rebound measures, and lock-ins. All of these problems have been discussed in the various papers of this special issue. The main message from these articles is that we urgently need to develop better conceptual and operational approaches to understand and characterize, let alone manage non-simple risks.

LESSONS FOR RISK GOVERNANCE

Risk governance endorses highly contextualized practices of dealing with risks. Therefore, it is not a model in the strict sense of the word. The idea of risk governance aims to serve a paradigm shift that helps risk professionals to familiarize themselves with a broader concept of risk (van Asselt and Renn in press). It is a dynamic governance

process of continuous and gradual learning and adjustment that permits a prudent handling of complexity, scientific uncertainty and/or socio-political ambiguity. Adaptive and integrative capacity in risk governance processes encompasses a broad array of structural and procedural means and mechanisms by which politics and society can handle collectively relevant risk problems. In practical terms, adaptive and integrative capacity is the ability to design and incorporate the necessary steps in a risk governance process that allow risk managers to reduce, mitigate or control the occurrence of harmful outcomes resulting from collectively relevant risk problems in an effective, efficient and fair manner (Brooks and Adger 2005). The adaptive and integrative quality of the process requires the capacity to learn from previous and similar risk handling experiences to cope with current risk problems and apply these lessons to cope with future potential risk problems and surprises.

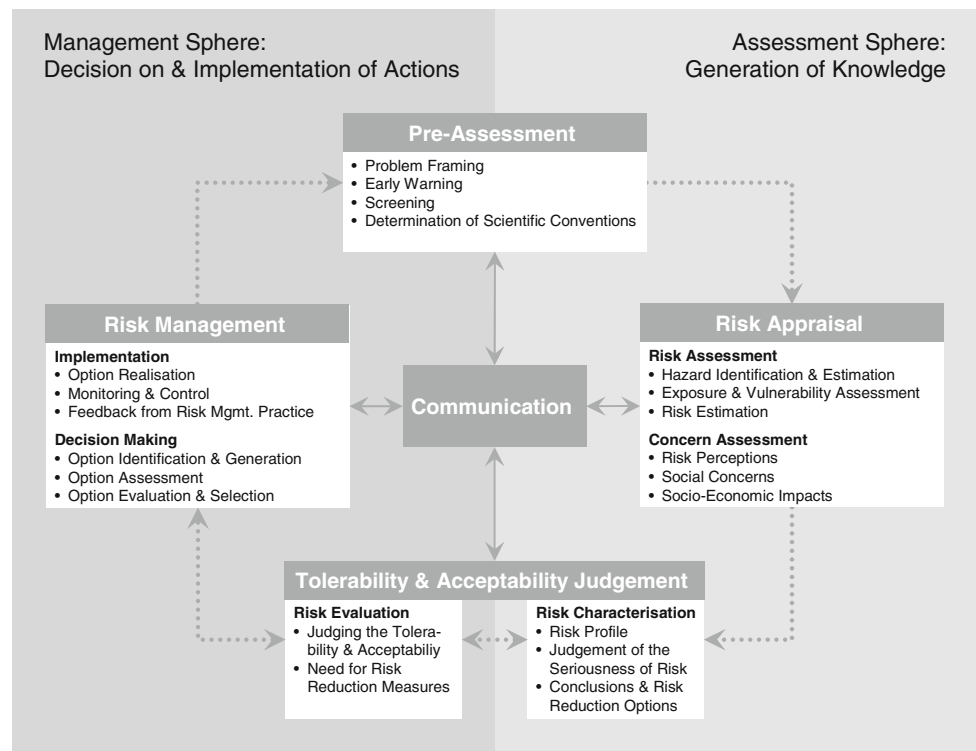
In 2005, the International Risk Governance Council suggested a process model of risk governance (Klinke and Renn 2002; IRGC 2005; Renn 2008; Renn and Walker 2008). This framework structures the risk governance process in four phases: pre-assessment, appraisal, characterization and evaluation, and risk management (see Fig. 2). Communication and stakeholder involvement were conceptualized as constant companions to all four phases of the risk governance cycle. The framework suggests a stage-by-stage process beginning with pre-assessment and ending with risk management. Each stage is further subdivided in functional components that need to be included for completing each step. Furthermore, there is a strict separation between knowledge acquisition and decision making and between physical and non-physical impacts (distinction in risk and concern assessment).

Given the insights from the articles in this special issue, Klinke and Renn have proposed some alterations to the IRGC risk governance model because it appears as being still too rigid to be applied to complex risk situations such as those imposed by the Baltic Sea ecological challenges (see also Klinke and Renn in press). There is a need for a comprehensive risk governance model with additional adaptive and integrative capacity that addresses four core functions:

- Systematically and consistently complementing the relevant risk handling functions in a risk governance cycle;
- Coping with vulnerabilities evoked by generic challenges of different orders of uncertainty;
- Providing adaptability and flexibility in risk governance institutions in response to actual outcome or expected consequences which may moderate the estimates about the risk; and

⁴ Some like-minded authors prefer to re-conceptualize risk in a way that renders the addition “uncertain” superfluous. For example, Aven and Renn (2009) suggest to redefine risk as a reference to “uncertainty about and severity of the consequences (or outcomes) of an activity with respect to something that humans value”. See also Rosa (2003). We agree with such definitions and we use them as well. In this paper, we, however, prefer to highlight the element of uncertainty, because in our view the deep acknowledgement of uncertainty is one of the major shifts compared to what has been referred to as the positivist, modernist or Knightian risk paradigm. So the use of the notion “uncertain risk” in this paper should be understood as a way to underscore the importance of uncertainty in risk governance.

Fig. 2 The IRGC Risk Governance Process (adopted from IRGC 2005, p. 65)



- Enhancing the resilience of the risk governance system by enhancing the capacity to retain the basic functions and structures of risk handling and to absorb disturbance in the risk handling components.

The modified framework suggested in this article consists of the following interrelated activities: pre-estimation, interdisciplinary risk estimation, risk characterization, risk evaluation, and risk management. This requires the ability and capacity of risk governance institutions to use resources effectively (see Fig. 3). Appropriate resources include institutional and financial means as well as social capital (e.g., strong institutional mechanisms and configurations, transparent decision-making, allocation of decision making authority, formal and informal networks that promote collective risk handling, education), technical resources (e.g., databases, computer soft- and hardware, research facilities, etc.), and human resources (e.g., skills, knowledge, expertise, epistemic communities, etc.). Hence the adequate involvement of experts, stakeholders and the public in the risk governance process is a crucial dimension to produce and convey adaptive and integrative capacity in risk governance institutions (cf. Stirling 2008). Since the social acceptance of any response of risk governance to risk problems associated with complexity, uncertainty and/or ambiguity is critical, risk handling and response strategies need to be flexible and the risk governance approaches need to be iterative and inclusionary.

Pre-Estimation

Risks are not real phenomena but mental constructions resulting from how people perceive uncertain phenomena and how their interpretations and responses are determined by social, political, economic and cultural contexts, and judgments (cf. Luhmann 1993; OECD 2003; IRGC 2005). At the same time, those mental constructions are informed by experience and knowledge about events and developments in the past that were connected with real consequences. The introduction of risk as a social construct with real consequences is contingent on the presumption that human action can prevent harm in advance. Risk as a 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 a destiny explained by religion 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 can neither anticipate all potential scenarios nor 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 and have to be *selective* in what they have chosen to be worth considering and what to ignore.

Therefore, pre-estimation involves *screening* as an exploration of a large array of actions and problems as candidates for risks. It is important to explore what

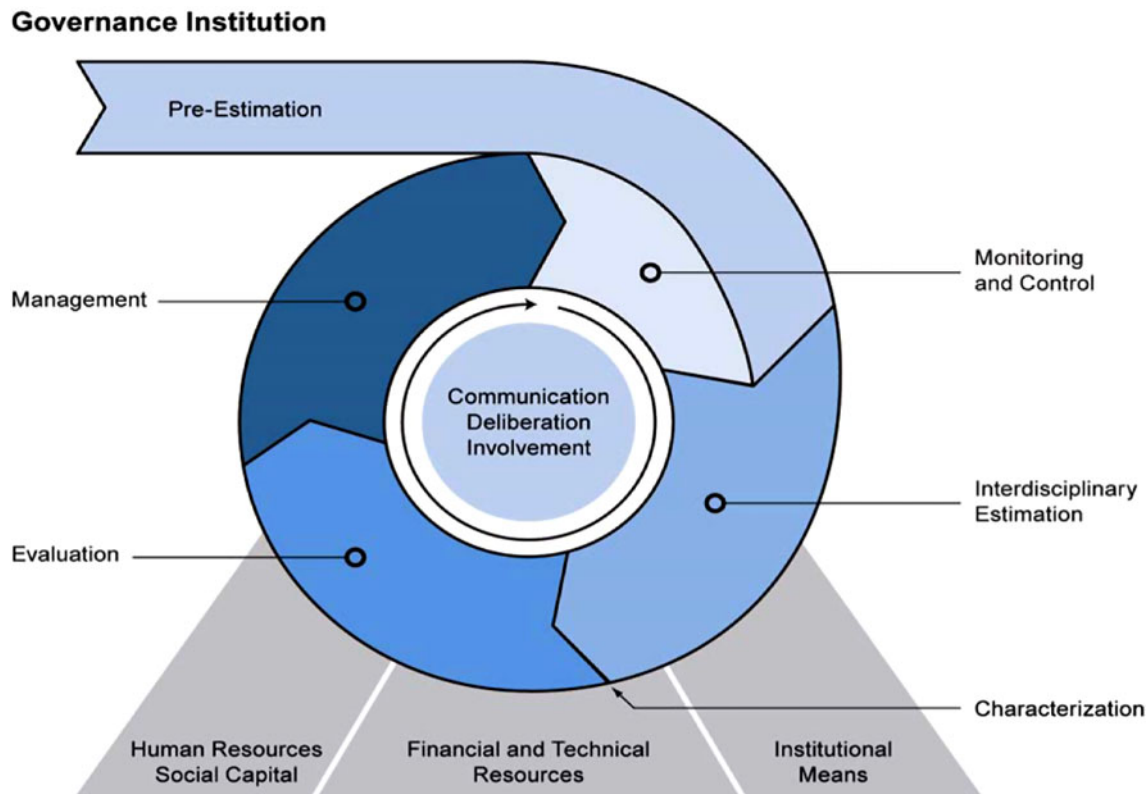


Fig. 3 A modified risk governance framework (based on Klinke and Renn in press)

political and societal actors (e.g., governments, companies, epistemic communities, nongovernmental organizations) as well as the general public identify as risks and what types of problems they frame in terms of risk and associate with uncertainty, complexity and ambiguity. This is referred to as *framing*: how do society and politics rely on schemes of selection and interpretation to understand and respond to those phenomena what is socially constructed as relevant risk topics (Kahneman and Tversky 2000; Reese 2007). According to Robert Entman:

to frame is to *select some aspects of a perceived reality and make them more salient in a communication text, in such a way as to promote a particular problem definition, casual interpretation, moral evaluation, and/or treatment recommendation* for the item described (Entman 1993, p. 52, italics in original).

Interpretations of risk experience depend on the frames of reference (Daft and Weick 1984). Recognition of framing implies that pre-estimation requires a multi-actor and multi-objective governance structure. Governmental authorities (national, supranational and international agencies), risk producers/opportunity takers (e.g., industry), those affected by risks and benefits (e.g., consumer

organizations, local communities, environmental groups on behalf of the environment) and interested parties (e.g., the media or experts) are all involved and often quarrel about the appropriate frame to conceptualize the problem. What counts as risk may vary among these actor groups.

The importance of framing has been illustrated by several articles in this special issue. In her analysis of the Swedish media, Jönsson (2011) concluded that prominent media figures scientific experts, organizations, and politicians are the dominating actors in framing, while citizens are more or less invisible. Eutrophication is not framed in terms of uncertainty concerning the risk and consequences, but rather in terms of main causes. This has major repercussions on how the problem is perceived by the general public. Consequences of eutrophication are then envisioned as proof of human error or institutional failure and not as a combination of human intervention and random variation. Hammer et al. (2011) investigated the various frames from the local stakeholders in a River Basin controversy. The results in their study pointed to the importance of institutional arrangements that can handle the variability of local frames and generate trade-offs between different solutions and priorities on different hierarchical levels.

Interdisciplinary Risk Estimation

For politics and society to arrive at reasonable decisions about risks in public interest, it is not enough to consider only the results of (scientific) risk assessment(s). 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 associated with the risk is needed and should be taken into account by risk managers.

Interdisciplinary risk estimation involves a systematic assessment of the risks to human health and the environment and assessment of related concerns as well as social and economic implications (cf. IRGC, International Risk Governance Council 2005; Renn and Walker 2008). The interdisciplinary estimation process should be informed 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 interdisciplinary risk estimation comprises two activities:

- (1) *Risk assessment*: producing the best estimate of the physical harm that a risk source may induce;
- (2) *Concern assessment*: identifying and analyzing 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 modeling, or structured hearings with stakeholders may be used.

There are different approaches and proposals how to address the issue of interdisciplinary risk estimation. 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). These include:

- *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 modeling 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 mobilization*: The broad social impact. Will the risk generate social conflict or outrage etc.? Subcategories here are:

- *Inequity and injustice* associated with the distribution of risks and benefits over time, space and social status;
- *Psychological stress and discomfort* associated with the risk or the risk source (as measured by psychometric scales);
- *Potential for social conflict and mobilization* (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.

Some of the criteria have been used by different risk agencies or risk estimation processes (for example, HSE 2001).

The article by Johannesson et al. (2011) as well as the paper by Pihlajamäki and Tynkkynen (2011) deal with complex risk issues relating to Baltic Sea ecological risks. The two papers conclude that scientific analyses of magnitude and probability distributions of harm are not sufficient to characterize the risks. This is partly due to the complexity, uncertainty, and ambiguity of the issues involved, partly caused by the sensitivity of the ecosystem and non-linear effects of human interventions into this system. Pihlajamäki and Tynkkynen (2011) distinguish five types of uncertainties that need to be addressed in the issue of eutrophication: (1) the uncertainty of knowledge concerning ecological processes, (2) the heterogeneity of knowledge, (3) the societal and political call for (certain) knowledge, (4) the contingency of the knowledge that ends up taken as a baseline for decision making and further research, and (5) the linkages of knowledge production, processing and communication to particular characteristics of individual researchers and research societies. These five types echo the need for multiple knowledge input and integration of risk assessments and concern assessments in order to assess the potential severity of the risk in terms of societal and environmental harm.

Risk Evaluation

A heavily disputed task in the risk governance process relates to the procedure of how to evaluate the societal acceptability or tolerability of a risk. In classical approaches, risks are ranked and prioritized based on a combination of probability (how likely is it that the risk will occur) and impact (what are the consequences, if the risk does occur) (Klinke and Renn 2002, in press; Renn 2008). However, in situations of uncertainty, complexity, and ambiguity, risks cannot be treated just in terms of likelihood (probability) and (quantifiable) effects. Also values

and issues such as reversibility, persistence, ubiquity, equity, catastrophic potential, controllability, and voluntariness should be integrated in risk evaluation. Furthermore, risk-related decision-making is not just about risks and usually not about a single risk. Evaluation requires risk(s)–benefit(s) evaluations and risk–risk trade-offs. Therefore, risk evaluation is by definition multi-dimensional. In order to evaluate risks the first step is hence to characterize the risks on all the dimensions that matter to the affected populations. Once the risks are characterized in a multi-dimensional profile, their acceptability can be assessed.

Furthermore, there are different legitimate viewpoints from which to evaluate whether there are or could be adverse effects and whether these risks are tolerable or even acceptable. Risks are acceptable in case they are considered low or non-existing, so additional regulatory efforts are considered unnecessary. Activities are tolerable if they are considered as worth pursuing for the benefit that they carry (Bouder et al. 2007). In cases of tolerable risks, additional regulatory efforts for risk reduction or coping are welcomed. Actors, however, respond to risks according to their own risk constructs and images, yielding several meaningful and legitimate interpretations of risk assessment outcomes (Keeney 2004). As a consequence, whether risks are acceptable, tolerable, or intolerable could be subject of considerable debate and intense controversy. Ambiguity is used to refer to such social situations around risk issues. Ambiguity results from divergent and contested perspectives on the justification, severity or wider meanings associated with a perceived threat (Stirling 2003).

How to draw the lines between “acceptable”, “tolerable” and “intolerable” is one of the most controversial tasks in the risk governance process. 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 demarcation lines, whereby participants in the Round Table represented industry, administrators, county officials, environmentalists, and neighborhood groups.

Irrespective of the selected means to support this task, the judgment on acceptability or tolerability is contingent on making use of a variety of different knowledge sources, in other words it requires taking the interdisciplinary risk estimation serious. For example, risk–benefit trade-offs have to be made when making decisions about industrial development goals versus environmental protection, in particular in densely populated areas such as the countries neighboring the Baltic Sea (Fig. 4).

Risk evaluations in general rely on causal and principal beliefs as well as world views (Goldstein and Keohane 1993). Causal beliefs refer to the scientific evidence from risk assessment, whether, how and to what extent the hazard potential might causes harm. This dimension emphasizes cause-effect relations and provides guidance which strategy is appropriate to achieve the goal of risk avoidance or reduction. However, the question of what is safe enough implies a moral judgment about acceptability of risk and the tolerable burden that risk producers can impose on others. The results of the concern assessment can provide hints of what kind of associations are present and which moral judgments people would prefer in a choice situation. Of major importance is the perception of just or unjust distribution of risks and benefits. How these moral judgments are made and justified depends to a large degree on cultural values and world views. They affect personal thinking and evaluation strategies and are shaped by collectively shared ontological and ethical convictions. The selection of strategies for risk handling is therefore understandable only within the context of broader world views. Hence society can never derive acceptability or tolerability from looking at the evidence alone. Likewise, evidence is essential if we are to know whether a value might be violated or not (or to what degree).

In sum, risk evaluation involves the deliberative effort to qualify risks in terms of acceptability and tolerability in a situation of uncertainty, ambiguity and complexity, which implies that neither the risks nor the benefits can be clearly identified. Multiple dimensions and multiple values have to be considered. Finally, risk evaluations may shift over time (de Vries et al. in press). Notwithstanding uncertainty,

Fig. 4 In risk evaluations trade-offs have to be made between environmental protection and industrial development (Photo by Robert Kautsky/Azote)



complexity and ambiguity, it may be well possible at a certain point in time to agree whether risks are acceptable, tolerable or intolerable. When the (in)tolerability or acceptability of risks is heavily contested, that is also highly relevant input to the decision-making process.

Linke et al. (2011) pointed out in their case study that the Regional Advisory Councils (RACs) linked to EU's Common Fisheries Policy were asked to submit information and knowledge to the risk estimation phase but did so during the phase of evaluation. The mixture of knowledge input and value application to judgments was one of the major reasons for the problems that occurred during the deliberations of the RACs. They concluded that one basic problem is a mismatch of the participation purpose (inclusion of stakeholders' knowledge) and the governance stage at which RACs are formally positioned (evaluation of management proposals). This case study emphasized the importance of distinguishing assessment from evaluation and the need to involve stakeholders in evaluation.

Risk Management

Risk management starts with reviewing the output generated in the previous phases of interdisciplinary risk estimation, characterization, and risk evaluation. If the risk is acceptable, no further risk management is needed. If the risk is considered intolerable, notwithstanding the benefits, risk management should be focused on banning or phasing out the activity creating the risk or, if that is not possible, to mitigate or fight the risk in other ways or to increase societal resilience. If the risk is considered tolerable, the benefits are worth the risk, but risk reduction measures are necessary. If risks are classified as tolerable public risk management needs to design and implement actions that render these risks either acceptable or sustain tolerability in the longer run by introducing risk reduction strategies, mitigation strategies, or strategies aimed at increasing resilience of society as a whole or particular communities. If the risk is contested, risk management can be aimed at finding ways to create consensus, or if that is impossible or highly unlikely, to design actions that increase tolerability among the parties most concerned and/or to stimulate alternative course of action for those who consider the risk acceptable or at least tolerable in view of the benefits or weighed against other risks.

Klinke and Renn (2002) and Renn (2008) have argued that there are different ways to design the process of identifying risk management options in situations of uncertainty, complexity, and ambiguity. In those situations, routine risk handling within risk assessment agencies and regulatory institutions is inappropriate for this category, since the risk problems are not sufficiently known and/or are contested. Klinke and Renn (2002) have suggested that

in case complexity is dominant and uncertainty and ambiguity are low, the challenge is to invite experts to deliberate with risk managers to understand complexity. Flood risk management may be an example in this case. Although the occurrence of floods follows a random pattern, one can address vulnerability and design emergency management actions well in advance. The major challenge is to determine the limit to which one is willing to invest in resilience. Yet once the complexity is well understood, it is a question of political will to implement the desired level of protection. The article by Garrelts and Lange (2011) emphasizes the need for state decisiveness in such cases: "For all the indispensability of participatory approaches—for reasons of integrating citizen's expertise, for reasons of the additional need for legitimacy in face of existing future uncertainty—it is the state that remains the institutional guarantor for ensuring that problems can be addressed from diverging perspectives (..) The ability of state agencies to intervene with sanctions and directives addresses the question of ultimate responsibility, which is all too often overlooked by participation oriented approaches". In cases of high complexity, low uncertainty and low ambiguity, this study seems to suggest a reverse movement from governance to government. We do not argue this conclusion holds for all flood risk management. It is well conceivable, for example, in situations in which uncertain climate change complicates the matter or in case societal actors resist to particular flood risk management options, such as higher dikes or dismantling settlements in flood plains, for aesthetic or cultural reasons (Wisner et al. 2004).

Likewise, Klinke and Renn (2002) have reasoned about the design of the management process concerning risk problems that are characterized by high uncertainty but low ambiguity. They argued that expanded knowledge acquisition may help to reduce uncertainty. If, however, uncertainty cannot be reduced (or only in the long run) by additional knowledge, Klinke and Renn (2002) advocate of what they refer to as "precaution-based risk management", which involves risk management options containment, diversification, monitoring, and substitution. Because the focal point here is to find the adequate and fair balance between being overcautious versus being not cautious enough, a reflective processing involving stakeholders is necessary to ponder concerns, economic budgeting and social evaluations. Hassler (2011) discusses regulatory regimes that could deal with high levels of uncertainty. He concludes that stricter monitoring will most likely not improve the effectiveness of this system. Instead, a more promising way ahead could be to look even closer at individual actors' incentive patterns and try to find institutional and politically viable mechanisms to induce better compliance.

For risk problems that are highly ambiguous (regardless of whether they rank low or high on uncertainty and complexity), Klinke and Renn (2002) recommend what they refer to as “discourse-based management” (compare Assmuth 2011; Hammer et al. 2011) who also argue for a deliberative style in risk management for highly ambiguous risks). This requires a demanding participative process, involving stakeholders as well as the affected public(s). The aim of such a process is to produce a collective understanding among all stakeholders and concerned public on how to interpret the situation and how to design procedures of justifying collectively binding decisions on acceptability and tolerability which are considered legitimate. In such situations, risk managers’ task is to create a situation in which those who believe that the risk is worth taking (perhaps because of self-interest) and those who believe that the pending consequences do not justify the potential benefits of the risky activity or technology are willing to respect each others’ views and to construct and create strategies that are acceptable to the various stakes and interests. But deliberation is not a guarantee for a smooth risk management process. Lidskog et al. (2011) argue that complexity and ambiguity relate to an inherent conflict that is difficult if not impossible to resolve. The reduction of complexity simultaneously implies reducing the number of actors seen as relevant or legitimate participants whereas the resolution of ambiguity requires a broad representation of all actors involved in the case. So it is difficult to find the right path between functionality and inclusiveness. In any case, our response to this inherent conflict is to invest in structuring an effective and efficient process of inclusion and closure (Renn 2008; Aven and Renn 2010).

In sum, neither the characterization (uncertain, complex, and/or ambiguous) of the systemic risk at hand nor the contingent evaluation of the risk (acceptable, tolerable, intolerable, disputed) result in a simple typology for risk management. Nevertheless, the characterizations and evaluations provide some guidance for risk management about how to design a process that holds the promise of being sensible, which risks are to be prioritized and which options seems sensible in which contexts. From the above reflection as well as similar reflections in other contributions to this special issue, it is clear that the traditional risk management style is not just inadequate to deal with systemic risks, but it might even fuel societal controversies around risk.

RISK COMMUNICATION AND PARTICIPATION

Effective mutual communication is one of the key challenges in risk governance. It is not a separate stage (in

contrast to how it is often treated), but central to the whole endeavor. Positively framed, communication is at the core of any successful risk governance activity. Negatively framed, a lack of communication destructs risk governance. Initially, risk communication has been approached in terms of educating and persuading the public (Fischhoff 1995). However, this deficit model has been questioned. As Pidgeon et al. (2005, p. 467) phrased it: “One of the most consistent messages to have arisen from social science research into risk over the past 30 years is that risk communication (..) needs to accommodate far more than a simple one-way transfer of information. (..) the mere provision of ‘expert’ information is unlikely to address public and stakeholder concerns or resolve any underlying societal issues”. Research on risk controversies has demonstrated that in general the public does not by definition misunderstand science and experts and governments may also misunderstand public perceptions (Irwin and Wynne 1996; Horlick-Jones 1998). Furthermore, risk communication and trust are delicately interconnected processes. Communication breakdowns may damage trust, while on the other hand, communication strategies that misjudge the context in terms of the level of, and reasons for, (dis)trust may boomerang back and actually increase distrust (Löfstedt 2005).

Notions of communication proliferate. We refer to communication as meaningful interactions in which knowledge, experiences, interpretations, concerns, and perspectives are exchanged (van Asselt and Renn in press). Communication in the context of risk governance refers to exchanges between policy makers, experts, stakeholders, and the general public, and among themselves. The aim of communication is to provide a better basis, also in terms of trust and social support, for responsible governing of uncertain, complex and/or ambiguous risks. To that end, dependent on the nature of the risks and the context for making governing choices, communication will serve various purposes. Communication might serve the sharing of information about the risks and possible ways of handling them. It might support building and sustaining trust among various actors through which particular arrangements or risk management measures become acceptable. It might result in actually involving people in risk-related decisions, through which they gain ownership.

However, communication in the context of risk governance is not simple. It is not just a matter of bringing people together. Social learning is required in order to find ways to discuss uncertainty, complexity and/or ambiguity. It is not enough that communication is organized. The key challenge is to facilitate that various actors from different backgrounds succeed in interacting meaningfully in the face of uncertainty, complexity, and/or ambiguity. Several of the articles in this special issue illustrate this

point: Lidskog et al. (2011) show examples of communication that increase conflict rather than resolving it. Jönsson (2011) demonstrates that the media can narrow our frame of risks and contribute to potential misunderstandings of the situation. Garrelts and Lange (2011) are skeptical about the potential of public participation in flood management and ask for more governmental accountability in this issue. The fact that communication is at the heart of the governance process does not mean that everyone is communicating with everyone during the whole process and that such communication is instrumental for increased resilience or better risk management. Social learning is therefore required to figure out which type of communication with whom is important in which phase. Furthermore, such communication requirements may differ dependent on the context, such as political culture, the dominant social values, and the trust-relationships between actors (Hood et al. 2002).

The above reflection on communication already features multiple actors. The 1996 US National Research Council report (Stern and Fineberg 1996) is generally considered an important milestone in the recognition of the need of risk decision making as an inclusive multi-actor process. Scholars using the term “risk governance” share the normative position that it is good and needed to involve interested and affected parties in collective decision making about risk (see for example, Stirling 2007; Lidskog 2008; Irwin 2008).

Inclusion has deep implications. Contrary to the current state of affairs in which risk topics are usually identified by experts, public values and social concerns may act as the driving agents for identifying risk topics. Inclusion does not just mean that various actors are included, but that they play a key role in framing (or pre-assessing) the risk (IRGC 2005; Renn and Schweizer 2009; see also Roca et al. 2008). Inclusion should be open and adaptive at the same time (Stirling 2004). Crucial issues in this respect are (see also Renn and Schweizer 2009):

- Who is included?
- What is included?
- What is the scope and mandate of the process?

Inclusion can take different forms: roundtables, open forums, negotiated rule-making exercises, mediation, or mixed advisory committees including scientists and stakeholders (Rowe and Frewer 2000; Renn 2008). Social learning is required to find out what level and type of inclusion is appropriate in view of the context and the type of risk, as there is lack of agreement on methodologies: they have contrasting strengths and weaknesses (Pidgeon et al. 2005).

Inclusion is defended for several reasons (compare Roca et al. 2008). First, it is argued that in view of uncertainty,

complexity and/or ambiguity, it is needed to explore various sources of information and to identify various perspectives. It is important to know what the various actors label as risk problems. In that view, inclusion is a means to an end: integration of all relevant knowledge and inclusion of all relevant concerns. Second, it is argued from a democratic perspective that actors affected by the risks and/or the ways in which the risks are governed have a right to participate in deciding about those risks. In that view, inclusion is not just a means, but an end in itself. At the same time, inclusion is a means to agree on principles and rules that should be respected in the processes and structures of collective decision-making. Third, it is argued that the more actors are involved in the weighing the essentially heterogeneous pros and cons, the more socially robust the outcome. When uncertainty, complexity and/or ambiguity reign, there is no simple decision rule. In that view, inclusion is also a way to organize checks and balances. Inclusion is thus supposed to support the co-production of risk knowledge, the coordination of risk evaluation and the design of risk management.

Also here, social learning is required. It is not a matter of degree: more inclusion does not equal better risk governance. The degree and type of inclusion may vary dependent on the phase and context. In each phase and context, it has to be thought through what kind and degree of inclusion is needed.

The challenge is to organize productive and meaningful communication with, and inclusion of, a range of actors, who have complementary roles and diverging interests. The available empirical analyses suggest that the attempt to include different stakeholders, to consider and deliberate their concerns and to provide a platform for the exchange of arguments can help to de-escalate conflicts and to legitimize the final decision that will always disappoint some actors in society (Beierle and Cayford 2002; US-National Research Council 2008).

CONCLUSION

We have attempted to explore the genesis and analytical scope of risk governance in the context of a broader turn from government to governance. We argued that in the context of risk the notion governance is used in a descriptive and normative sense: both as a description of how decisions are made and as a model for how to improve structures and processes of risk policy making. Risk governance draws the attention to the fact that not all risks are simple: they cannot all be calculated as a function of probability and effect. Many risks, which require societal choices and decisions, are adequately characterized as complex, uncertain and/or ambiguous. It is a consistent

finding, however, that in most cases they are treated, assessed and managed as if they were simple. The many failures to deal adequately with risks such as genetic engineering, nuclear energy, financial crisis, cyber-terrorism as well as environmental risks such as chemical pollution or eutrophication demonstrate an urgent need to develop alternative concepts and approaches to deal with uncertain, complex and/or ambiguous risks.

We have made an attempt to modify the IRGC framework. At the core of this paper was the idea of adaptive and integrative risk governance. The goal has been to illustrate the different activities—pre-estimation, interdisciplinary risk estimation, risk characterization, risk evaluation, risk management as well as communication and involvement—and we have discussed the challenges for risk management.

The modifications of the IRGC framework were partly based on critical reviews in the literature and partly informed by the experiences and lessons drawn from the papers in this special issue. They provided an excellent resonance board for testing the main implications of the risk governance concept and added new insights. It became clear from reading these articles that the ecological risks of the Baltic Sea can be characterized as systemic risks with a high level of complexity, uncertainty and ambiguity. This special issue demonstrates a need for new ways to estimate, evaluate and manage these risks. Furthermore, the various papers identified an urgent need to improve risk communication and participation.

The case studies in this special issue demonstrate that risk governance is not a fancy buzzword, but that it should be understood as a plea for a paradigm shift. Paradigms and reforms do not shift in the abstract, but shift in practices. It is not an easy transition. Yet, we hope that taking stock in this special issue helps to stimulate and facilitate risk practices in the Baltic Sea to change.

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