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New Challenges for Risk Research and Risk Management

1. *Introduction*

The recent risk related scandals from BSE to collapsing bridges provide ample evidence that there is no simple recipe for evaluating and managing risks. In view of worldwide divergent preferences, variations in interests and values and very few if any universally applicable moral principles, risks must be considered as heterogeneous phenomena that preclude standardized evaluation and handling. At the same time, however, risk management and policy would be overstrained if each risky activity required its own strategy of risk evaluation and management. What risk managers need is a concept for evaluation and management that on the one hand ensures integration of social diversity and multidisciplinary approaches, and on the other hand allows for institutional routines and standardized practices.

This new challenge of risk management is accompanied by the emergence of a new concept of risk, called systemic risks (OECD 2002). This term denotes the embeddedness of any risk to human health and the environment in a larger context of social, financial and economic risks and opportunities. Systemic risk are at the crossroads between natural events (partially altered and amplified by human action such as the emission of greenhouse gases), economic, social and technological developments and policy driven actions, both at the domestic and the international level. These new interrelated risk fields also require a new form of risk analysis, in which data from different risk sources are either geographically or functionally integrated into one analytical perspective. Systemic risk analysis requires a holistic approach to hazard identification, risk assessment and risk management. Investigating systemic risks goes beyond the usual agent-consequence analysis and focuses on interdependencies and spillovers between risk clusters.

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Systemic risk management and evaluation needs to include the following tasks (Renn 1997):

- Widening the scope of targets for using risk assessment methodologies beyond potential damages to human life and the environment, including chronic diseases; risks to wellbeing; and interaction with social lifestyle risks (such as smoking, sport activities, drinking and others);
- addressing risk at a more aggregate and integrated level, such as studying synergistic effects of several toxins or constructing a risk profile of an individual collective lifestyle that encompasses several risk causing facilities;
- studying the variations among different populations, races, and individuals and getting a more adequate picture of the ranges of sensibilities with respect to operators' performance, lifestyle factors, stress levels, and impacts of external threats;
- integrating risk assessments in a comprehensive problem solving exercise encompassing economic, financial and social impacts so that the practical values of its information can be phased into the decision making process at the needed time and that its inherent limitations can be compensated through additional methods of data collection and interpretation;
- developing new production technologies that are more forgiving, tolerate a large range of human error and provide sufficient time for initiating counteractions.

Modern societies need better concepts for clarifying these new tasks of risk assessment and risk management and developing substantive as well as procedural suggestions for risk management agencies. The basis for such concepts can be taken from a novel approach to risk evaluation, classification and management developed by the German Scientific Advisory Council for Global Environmental Change (WBGU 2000). There are two crucial elements of this approach: first an expansion of factors that should be considered when managing systemic risks; second, the integration of analytic-deliberative processes into the regulatory framework. Both aspects will be discussed in the next sections.

2. *Systematic Risk Evaluation*

A holistic and systemic concept of risks cannot reduce the scope of risk assessment to the two classic components: extent of damage and probability of occurrence. This raises the question: Which other physical and social impact categories should be included in order to cope with the phenomenological challenges of systemic risks and how can one justify the selection?

The German Advisory Council on Global Change (WBGU 2000) has addressed this problem in its 1998 Annual Report. The Council organized several expert surveys on risk criteria (including experts from the social sciences) and performed a meta-analysis of the major insights from risk assessment and perception studies. The Coun-

cil also consulted the literature on similar approaches in countries such as United Kingdom, Denmark, Netherlands and Switzerland (WBGU 2000). They asked experts to provide special reports on this issue to the authors. The following criteria were selected as the result of a long exercise of deliberation and investigations:

- *Extent of damage* (adverse effects in natural units such as deaths, injuries, production losses etc.);
- *Probability of occurrence* (estimate for the relative frequency of a discrete or continuous loss function);
- *Incertitude* (overall indicator for different uncertainty components);
- *Ubiquity* defines the geographic dispersion of potential damages (intragenerational justice);
- *Persistency* defines the temporal extension of potential damages (intergenerational justice);
- *Reversibility* describes the possibility to restore the situation to the state before the damage occurred (possible restoration are e.g. reforestation and cleaning of water);
- *Delay effect* characterizes a long time of latency between the initial event and the actual impact of damage. The time of latency could be of physical, chemical or biological nature;
- *Violation of equity* describes the discrepancy between those who grasp the benefits and those who bear the risks; and
- *Potential of mobilization* is understood as violation of individual, social or cultural interests and values generating social conflicts and psychological reactions by individuals or groups who feel inflicted by the risk consequences. They could also result from perceived inequities in the distribution of risks and benefits.

After the WBGU proposal has been reviewed and discussed by many experts and risk managers, the Center of Technology Assessment in Stuttgart refined the compound criterion "mobilization" and divided it into four major elements (Renn and Klinke 2001):

- 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.

3. *The Three Challenges of Risk Management*

There are three central challenges to risk management: complexity, uncertainty, and ambiguity. Complexity refers to the difficulty of identifying and quantifying causal links between a multitude of potential candidates and specific adverse effects (WBGU 2000, 195ff.). The nature of this difficulty may be traced back to interactive effects among these candidates (synergisms and antagonisms), long delay periods between cause and effect, inter-individual variation, intervening variables, and others. Uncertainty is different from complexity. It is obvious that probabilities themselves represent only an approximation to predict uncertain events. It seems prudent to include other additional uncertainty components in one's risk management procedure. Which other components should be included? There is no established classification of uncertainty in the literature (van Asselt 2000, 93-138). Authors use different terms and descriptions such as incertitude, variability, indeterminacy, ignorance, lack of knowledge, and others. In order to be more systematic on this complex topic, the following decomposition seems to reflect the broader concept of uncertainty (Van Asselt 2000; Renn und Klinke 2001):

– *variability* (observed or predicted variation of individual responses to an identical stimulus among the individual targets within a relevant population such as humans, animals, plants, landscapes, etc.). In risk management, safety factors have been used to cover this variability;
– *measurement errors* (imprecision or imperfection of measurement, problems of drawing inferences from small statistical samples, extrapolation from animal data, biosurveys or other experimental data onto humans, uncertainties of modeling, including the choice of functional relationships for extrapolating from large to small doses; all of these usually expressed through statistical confidence intervals);
– *indeterminacy* (resulting from a genuine stochastic relationship between cause and effect(s), apparently non-causal or non-cyclical random events, or badly understood non-linear, chaotic relationships);
– *lack of knowledge* (resulting from ignorance, from the deliberate definition of system boundaries and hence exclusion from external influences, measurement impossibilities, and others).

All these different elements have one feature in common: uncertainty reduces the strength of confidence in the estimated cause and effect chain. If uncertainty plays a large role, in particular indeterminacy or lack of knowledge, the risk-based approach becomes counter-productive. Judging the relative severity of risks based on uncertain parameters, does not make much sense. Under these circumstances, management strategies belonging to the precautionary management style are required. The precautionary approach has been the basis for much of the European environmental and health protection legislation and regulation (Bennet 2000; Klinke and Renn 2001).

The last term in this context is ambiguity or ambivalence. This term denotes the variability of (legitimate) interpretations based on identical observations or data assessments. Most of the scientific disputes in the fields of risk analysis and management do nor refer to differences in methodology, measurements or dose-response functions, but to the question of what all this means for human health and environmental protection. Again high complexity and uncertainty favor the emergence of ambiguity, but there are also quite a few simple and almost certain risks that can cause controversy and thus ambiguity.

4. *The Need for Deliberation in Risk Management*

How can one deal with complexity, uncertainty and ambiguity in risk management? Deliberative methods should play a major role to cope with all three challenges. First, resolving complexity requires deliberation among experts. This type of deliberation can be framed as "epistemological discourse" (Renn 2003). Within an *epistemological discourse* experts (not necessarily scientists) argue over the factual assessment with respect to the criteria that the WBGU proposed. The objective of such a discourse is the most adequate description or explanation of a phenomenon (for example the question, which physical impacts are to be expected by the emission of specific substances). The more complex, the more multidisciplinary and the more uncertain a phenomenon appears to be, the more necessary is a communicative exchange of arguments among experts. The goal is to achieve a homogeneous and consistent definition and explanation of the phenomenon in question as well as a clarification of dissenting views. The discourse produces a profile of the risk in question on the selected criteria.

If risks are associated with high uncertainty, scientific input is only the first step of a more complex evaluation procedure. It is still essential to compile the relevant data and the various arguments for the positions of the different science camps. Information about the different types of uncertainties have to be collected and brought into a deliberative arena. This type of discourse requires the inclusion of stakeholders and public interest groups. The objective here is to find the right balance between too little and too much precaution. There is no scientific answer to this question and even economic balancing procedures are of limited value, since they stakes are uncertain. This type of deliberation could be framed as "reflective discourse". *Reflective discourse* deals with the clarification of knowledge (similar to the cognitive) and the assessment of trade-offs between the competing extremes of over- and underprotection. Reflective discourses are mainly appropriate as means to decide on risk-averse or risk-prone approaches to innovations. This discourse provides answers to the question of how much uncertainty one is willing to accept for some future opportunity. Is taken the risk worth while the potential benefit?

The last type of deliberation, which can be framed as *participatory discourse*, is focused on resolving ambiguities and differences about values. Established proce-

dures of legal decision making, but also novel procedures, such as mediation and direct citizen participation belong to this category. Participatory discourses are mainly appropriate as means to search for solutions that are compatible with the interests and values of the people affected and to resolve conflicts among them. This discourse involves weighting of the criteria and an interpretation of the results. Issues of fairness and environmental justice, visions on future technological developments and societal change and preferences about desirable lifestyles and community life play a major role in these debates.

It is clear that these different types of discourse need to be combined or even integrated when it comes to systemic risks. It is essential, however, to distinguish the specific type of discourse that is needed to resolve the issue at question.

5. *Implications for Policy Makers*

The central question for policy makers are about the suitable approaches and instruments as well as the adequate risk assessment practices to understand the impacts of risks and to assess and evaluate their contribution to health-related, environmental, financial and political risks (and, of course, opportunities). In addition, the link to strategic policy concerns as they relate to economic development and governance needs to be clarified. One of the most challenging topics here is the interpenetration of physical, environmental, economic and social manifestations of risks. Risk management is not only a task for risk management agencies, but also an imperative mandate for organizations dealing with the economic, financial, social and political ramifications.

It is not sufficient any more to look into the probability distribution of potential losses associated with a risk source. To establish a framework for good governance, a more stringent, logically well-structured and promising decision-making process is required. Risk managers need new principles and strategies, which are globally applicable to manage systemic risks. 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), over new assessment and management tools leading to improved methods of effective risk communication and participation.

The promises of new developments and technological breakthroughs need to be balanced against the potential evils that the opening of Pandora's box may entail. This balance is not easy to find as opportunities and risks are emerged in a cloud of uncertainty and ambiguity. The dual nature of risk as a potential for technological progress and as a social threat demands a dual strategy for risk management. It will be one of the most challenging tasks of the risk community to investigate and propose more effective, efficient and reliable methods of risk assessment and risk management while, at the same time, ensure the path towards new innovations and technical breakthroughs.

BIBLIOGRAPHY

Bennet, P.G. (2000), Applying the Precautionary Principle: A Conceptual Framework. In: M.P. Cottam; D.W. Harvey; R.P. Paper and J. Tait (eds.): Foresight and Precaution. Volume 1. Rotterdam and Brookfield: A.A. Balkema, 223-227.

Klinke, A. und Renn, O. (2001), Precautionary Principle and Discursive Strategies: Classifying and Managing Risks. In: Journal of Risk Research, Jhg. 4, Nr. 2, 159-173.

OECD, *Emerging Systemic Risks. Final Report to the OECD Futures Project*. OECD, Paris (March 18, 2003).

Renn, O. (2003), The Challenge of Integrating Deliberation and Expertise: Participation and Discourse in Risk Management. In: T.L. MacDaniels and M.J. Small (eds.): *Risk Analysis and Society: An Interdisciplinary Characterization of the Field*. Cambridge: Cambridge University Press.

Renn, O. and Klinke, A. (2001), Environmental Risk – Perception, Evaluation and Management: Epilogue. In: G. Böhm; J. Nerb; T. McDaniels and H. Spada (eds.): *Environmental Risks: Perception, Evaluation and Management*. Amsterdam et al.: Elsevier Science, 275-299.

Van Asselt, M.B.A. (2000), *Perspectives on Uncertainty and Risk*, Dordrecht and Boston: Kluwer.

WBGU, German Advisory Council on Global Change 2000: World in Transition. Strategies for Managing Global Environmental Risks. Annual Report 1998. Berlin et al.: Springer.