Integrating the Concepts of Foresight and Prediction for improved Disaster Risk Management

Christoph Aubrecht
AIT Austrian Institute of Technology
Foresight & Policy Development Department
christoph.aubrecht@ait.ac.at

Sérgio Freire
New University of Lisbon
e-GEO, Geography and Regional Planning Research Center
sfreire@fcsh.unl.pt

Josef Fröhlich
AIT Austrian Institute of Technology
Foresight & Policy Development Department
josef.froehlich@ait.ac.at

Beatrice Rath
AIT Austrian Institute of Technology
Foresight & Policy Development Department
beatrice.rath@ait.ac.at

Klaus Steinnocher
AIT Austrian Institute of Technology
Foresight & Policy Development Department
klaus.steinnocher@ait.ac.at

ABSTRACT

This discussion paper focuses on conceptualizing the ultimate goal in disaster management, i.e. *reduction of future risks and impacts* and explicitly highlights how actions taken in various phases of integrated disaster risk management influence vulnerability and eventually overall risk characteristics. First, the advancement of the disaster management concept evolving from a cyclic perspective to a spiral view is described and the various stages of disaster management including risk analysis, mitigation, and response are explained. In an attempt to improve and advance disaster risk management, next, the *concepts of foresight and prediction* are described and its major differences are highlighted. Finally, the basic framework of *risk governance* is considered for integrating foresight and prediction and thus lifting disaster management to the next level. Active and transparent communication and participation is seen as the key for successfully implementing risk governance.

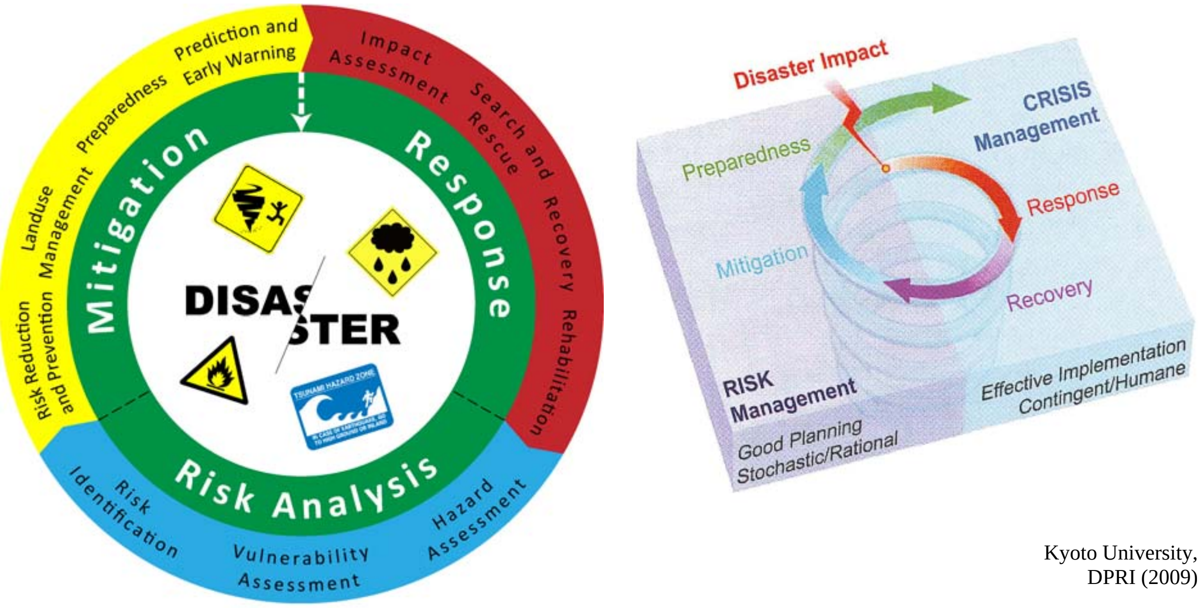
Keywords

Participation, involvement, public awareness, risk perception, risk governance.

THE ADVANCEMENT OF THE DISASTER MANAGEMENT CONCEPT – FROM CYCLE TO SPIRAL

Disaster management has widely been regarded as a cyclic multi-stage concept, ideally starting with (1) risk analysis, followed by (2) mitigation efforts to minimize the impacts of future events, and finally rounded off by (3) a response phase after a disaster strikes (Aubrecht et al., 2010). Different types of hazards such as hurricanes, tsunamis, floods, earthquakes and fires feature individual characteristics and require adapted actions in all stages. Generally speaking, mitigating impacts of disasters starts with risk reduction and prevention measures where land use management plays an important role as well as general preparedness both in terms of social and economic activities and infrastructural measures. Prediction and early warning preceding the next hazard event form the final part of this stage. The phase of response includes first-pass impact assessment and accordingly coordinated search and rescue efforts as well as follow-on recovery and rehabilitation.

Reviewing Statement: This short paper has been fully double-blind peer reviewed for clarity, relevance and significance.



Kyoto University, DPRI (2009)

Figure 1. The disaster management cycle vs. the disaster management spiral

Risk analysis as an integral part of disaster management is composed of hazard and vulnerability assessment. Both aspects are highly sensitive to spatial and temporal variation. Most aspects of hazard investigations have a spatial component where both Earth Observation data and terrestrial surveys provide essential information for delineation of potentially affected areas and monitoring environmental conditions. The mere incidence of a 'natural hazard' does not, however, necessarily cause negative effects, e.g. wildfires are an important factor for ecosystem stability and recurring flooding often benefits riparian forests and agricultural areas. The term disaster is thus not used until severe impacts on social systems including human beings and associated assets (i.e. economic, infrastructural) are caused. This is where the complex and dynamic dimensions of vulnerability come into play, being defined by a set of interrelating input factors including exposure and sensitivity, initial coping capacity and social response of a system. Variable patterns of vulnerability determine where and when a mere natural event potentially turns into a disaster. Spatio-temporal modeling of human exposure (e.g. daytime/nighttime, weekends, seasonal variations) constitutes essential information for building appropriate adaptation strategies and thus reducing the residual risk.

Both mitigation and response actions in fact aim at reducing overall future risk. This is obvious for the mitigation phase, but not less important for the response phase, where well-organized search and rescue actions and also coordinated recovery and rehabilitation support can dramatically reduce overall impact on a social system. Seeing this in an ex ante perspective, a general reduction of social vulnerability becomes apparent. Vulnerability can therefore also be regarded as a time-dependent function of the abovementioned measures.

With all different stages featuring spatially and temporally variable components, the described well-established concept can be further elaborated by figuratively unrolling the cycle and moving to an infinite disaster management spiral (Figure 1). Learning from past disasters as well as envisioning future developments of social systems and corresponding adaptation of disaster management processes is essential in minimizing impacts of future events. It is however impossible to achieve zero risk. The residual risks keep the spiral on the loop despite continuous improvements in management practices.

IMPROVING DISASTER MANAGEMENT THROUGH INTEGRATION OF PREDICTION AND FORESIGHT IN A RISK GOVERNANCE FRAMEWORK

In the following paragraphs the concepts of foresight and prediction will be highlighted. For scientists involved in the natural hazards community, foresight might often be a novel term and on first sight might be assumed similar to prediction. Within the social science and policy research community, however, the concept of foresight can even be considered completely contradictory to approaches of predicting future conditions (cf., Cuhls, 2003). After explaining major differences in the conceptual approaches, risk governance will be presented as a framework which enables integrating foresight and prediction in one consistent set of spheres interconnected through risk communication processes.

Foresight and prediction – two contradicting concepts?

Foresight

Ongoing and accelerated structural changes in social, economic, and technological dimensions require a new way of future-oriented thinking. Policy- and decision-makers are facing an increasingly highly dynamic and complex environment with traditional value systems declining in importance. This environment is exposed to various types of tension, such as resource scarcity, demographic change, climate change, and conflicting stakeholder interests. New methods are needed which pro-actively support decision-making processes by developing future-oriented scenarios, and assist in governing and controlling complex systems. With a focus on creating a strategic framework for better-informed policies, **foresight** is based on participative, transparent, and flexible communication processes, seen in contrast to the limited scope of action for individual actors. Many social science disciplines refer to long-established paradigmatic traditions. Socially-oriented foresight processes which have greatest impact in the context of disaster management thus comprise considerable specific problems as addressed by Miles et al. (2003). Foresight activities initiate stakeholder and subject expert mobilization for seeking consistent scenarios through common visions and coherent strategic actions in order to accomplish goals and prospects. Bringing together experts with people from different disciplinary and institutional backgrounds, foresight activities facilitate effective knowledge distribution and collective reasoning and enable changes in the perception of involved persons, eventually resulting in potential impacts on policy-making in the next stage (after van Langenhove, Berloznik et al., 2002, and a description of 'Foresight Processes and Governance' at www.ait.ac.at/departments/foresight-policy-development/).

According to Martin (1995) "*Foresight is the process involved in systematically attempting to look into the longer-term future of science, technology, the economy, environment and society with the aim of identifying the emerging generic technologies and the underpinning areas of strategic research likely to yield the greatest economic and social benefits"*. It is very important to distinguish foresight and forecasting. Foresight is a process rather than a technique and it is not aimed at predicting the future but **shaping or constructing the future** by defining and living up to common long-term visions and desired conditions. Cuhls (2003) explains that foresight is not planning, but that foresight results would provide some sort of information about the future and can therefore be considered one step in decision planning and preparation. In the 'Foresight for Europe' report prepared for the European Commission by van Langenhove, Berloznik et al. (2002) it is stated that "*The future is there to be made. It is something shaped by people through their purposeful acts and through the unintended consequences of their acts. As such, the future is not there to be 'predicted' but to be socially constructed. Systematic thinking what might or could happen can be part of such a construction. As a field of enquiry, the systematic study of the future is nothing more than a tool in choosing and creating the most desirable future… The goal is not to predict THE future, but to imagine A future made possible by changes in technology, life style, work style, regulation, global geopolitics and the like.*"

Prediction

The term **prediction** to some extent contradicts the foresight concept, as becomes apparent in the second definition cited above, stating that '*the future is not there to be predicted, but to be socially constructed*'. This vision might well be applicable when dealing with long-term technological and social progress and advancement. However, in the context of disaster management it is to a certain degree essential to 'predict' the future, or at least come up with potential prediction scenarios. This applies in particular to the late phase of the mitigation stage, where best accurate (short-term) predictions form the basis for early warning systems and planning of first-response measures.

Every prediction of a future state implies a certain degree of uncertainty (e.g., Shimokawa and Takeuchi, 2006). In the context of natural hazard research, a lot of scientific conclusions have been drawn and many types of hazards can be well described in terms of characteristics and consequences. Scientists can roughly predict where and when a hurricane will make a landfall and how destructive it will be. Atmospheric conditions which favor the formation of tornadoes can be monitored and complex river flood models can simulate inundation zones and related infrastructure exposure. In each case this is 'simply' based on tracing the relevant precursors, such as storm clouds, winds, and rains, and issuing an alarm when the situation passes certain pre-defined thresholds (Buchanan, 2001). Other hazards, such as earthquakes, seem to be unpredictable and do not show any conclusive patterns of reoccurrence (Geller, 1997). Probably one of the most well-known examples is the case of the Parkfield area in California (USA) where scientists were sure to have found evidence for the cyclic nature of earthquakes when analyzing a seemingly consistent time series of events with regular reoccurrence intervals, but eventually failed with prediction (i.e. a prediction for a 95% time window, 1985-1993, was unsuccessful since no significant event occurred before 2004; Bakun et al., 2005; Jackson and Kagan, 2006)

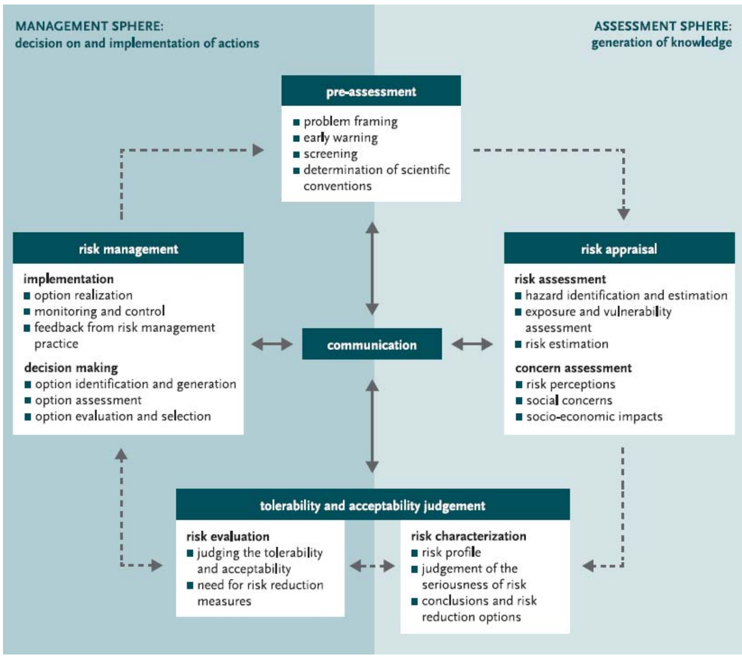


Figure 2. Basic elements of the risk governance framework (according to Renn, 2008)

Risk governance as an approach to improved disaster management

An analysis presented by Aubrecht et al. (2009) confirmed that the actual impact of a disaster is not directly related to pre-installed risk-reducing measures. For example, protection measures providing safe conditions until a certain threshold often lead to distorted **human risk perception**. Taking flood protection as an example, the hazard of flooding is eliminated up to a certain flood dimension through the installation of levees and dams. The residual risk of rare but very large floods is not perceived as such by humans. Built-up areas are extended to these 'risk-freed' regions without considering the residual flood risk. This increases the probability of high damage costs and direct impact on humans (e.g. casualties) as a consequence of flood events exceeding the protection capacities of technical measures. Along those lines, the concept of **sensemaking** (i.e. behavior which allows the individual to construct and design his/her movement through time-space) should be mentioned and applied to disaster risk management and particular to better understanding crisis situations. Weick (1988) argues that "*commitment, capacity, and expectations affect sensemaking during crisis and the severity of the crisis itself*". He refers to stress as an accompaniment of crises situations, and explains that many crises escalate because of the secondary effects of **crisis-induced stress**. Seeing sense-making as central to all communication situations – e.g. interpersonal, mass, cross-cultural, societal (Dervin, 1983) – that approach fits very well in this context. Referring to the factor of social response included in the vulnerability concept, active public communication can play an important role also in disaster mitigation and prevention. A well informed society aware of environmental risks and hazards and understanding that it is impossible to achieve zero risk (Motoyoshi, 2006) is less vulnerable to certain natural events, a condition which eventually reduces disaster impacts and damage costs.

An overview of the concept of risk governance, which promises to offer a comprehensive means of integrating risk identification, assessment, management, and communication, is given by Renn (2008). With governance implying a much broader scope of risk management than individual actors' actions, the author refers to the involvement of the four central actors in modern plural societies: governments, economic players, scientists, and civil society. According to Renn and Walker (2008) governance also includes "*building and using scientific knowledge, fostering innovation and technical competences, developing and refining competitive strategies, and promoting social and organizational learning*". Looking at the structure of the risk governance framework as illustrated in Figure 2, we see two interrelated spheres: (1) an assessment sphere basically focusing on generation of knowledge and (2) a management sphere where decisions are made and actions are implemented. Now, coming back to foresight and prediction, we see both approaches integrated in this basic conceptual framework. Foresight activities can be of particular interest and importance in the assessment sphere where risk perceptions, social concerns and potential social impacts are assessed and future risk profiles and risk reduction options are evaluated. The participatory nature of foresight is of utmost significance in the context of tolerability and acceptability judgment where also the long-term development of social systems has to be considered.

By fostering participation, foresight activities strengthen **public awareness** and **risk perception among relevant stakeholders**. Communication and participation is the key for successfully implementing risk governance. Early warning might function very well hazard-wise, relying on monitoring systems and predictions of certain physical conditions, but if the exposed population is not informed and not aware or if it is not convinced to 'accept' and cope with residual risk, disaster management will eventually not succeed, in particular from a **social perspective**. Therefore, just through integration of both long-term visions of future developments and short-term risk assessments and hazard predictions the risk governance concept can be applied within the disaster management concept. Looking more at the **economic aspects** of disaster management, risk-reducing efforts are often neglected and risks are rather passed on in a monetary sense (e.g. insurance, re-insurance). Pre-disaster mitigation actions usually have a high payoff in case actual crisis situations occur, but particularly the private sector is often not willing to invest, bearing the likely option that 'nothing' would happen. Future-oriented research is able to lay the foundations for changes very early, i.e. by guiding and initiating incremental adaptations for moving a system to a state of better preparedness (cf., Lindblom's "science of muddling through", 1959).

REFERENCES

1. Aubrecht, C., Köstl, M., Knoflacher, M., Steinnocher, K. (2009) The importance of active public communication - Settlement systems and land use patterns seen from a disaster perspective. In M. Schrenk, et al., eds., *Strategies, Concepts and Technologies For Planning the Urban Future*. REAL CORP 2009: 14th International Conference on Urban Planning, Regional Development and Information Society. Sitges, 895-900.
2. Aubrecht, C., Freire, S. and Steinnocher, K. (2010) Spatio-temporal aspects of vulnerability: How all comes together in integrated disaster risk management. In H. P. Nachtnebel, et al., eds., *Sharing IDRiM experiences under different socio-economic and cultural contexts*. First Annual Conference of the International Society for Integrated Disaster Risk Management - IDRiM 2010. Vienna, Sept. 2010.
3. Bakun, W. H., et al. (2005) Implications for prediction and hazard assessment from the 2004 Parkfield earthquake. *Nature*, 437, 7061, 969-974.
4. Buchanan, M. (2001) *Ubiquity - Why catastrophes happen*, Three Rivers Press, New York.
5. Cuhls, K. (2003) From forecasting to foresight processes - New participative foresight activities in Germany. *Journal of Forecasting*, 22(2-3), 93-111.
6. Dervin, B. (1983) *An overview of Sense-Making research: Concepts, methods, and results to date*. Annual Meeting of the International Communication Association. Dallas.
7. Geller, R. J. (1997) Earthquake prediction: a critical review. *Geophysical Journal International*, 131, 3, 425-450.
8. Jackson, D. D. and Kagan, Y. Y. (2006) The 2004 Parkfield Earthquake, the 1985 Prediction, and Characteristic Earthquakes: Lessons for the Future. *Bulletin of the Seismological Society of America*, 96, 4B, 397-409.
9. Kyoto University, DPRI (2009) Disaster Management Spiral (brochure published in 2009).
10. Lindblom, C. E. (1959) The Science of "Muddling Through". *Public Administration Review*, 19(2), 79-88.
11. Martin, B. (1995) Foresight in Science & Technology. *Technology Analysis & Strategic Management*, 7, 139-168.
12. Miles, I., Keenan, M., Kaivo-Oja, J. (2003) Handbook of Knowledge Society Foresight, European Foundation for the Improvement of Living and Working Conditions. Available at http://www.eurofound.europa.eu/publications/htmlfiles/ef0350.htm (last accessed on 5 Jan 2011)
13. Motoyoshi, T. (2006) Public Perception of Flood Risk and Community-based Disaster Preparedness. In S. Ikeda, et al., eds., *A Better Integrated Management of Disaster Risks: Toward Resilient Society to Emerging Disaster Risks in Mega-Cities*. TERRAPUB Terra Scientific Publishing Company, Tokyo, 121-134.
14. Renn, O. (2008) Concepts of Risk: An Interdisciplinary Review - Part 2: Integrative Approaches. *GAIA - Ecological Perspectives for Science and Society*, 17, 2, 196-204.
15. Renn, O. and Walker, K. (2008) Lessons learned: A re-assessment of the IRGC framework on risk governance. *The IRGC risk governance framework: Concepts and practice*. Springer, Heidelberg, 331-367.
16. Shimokawa, S. and Takeuchi, Y. (2006) Uncertainty in Flood Risks and Public Understanding of Probable Rainfall. In S. Ikeda, et al., eds., *A Better Integrated Management of Disaster Risks: Toward Resilient Society to Emerging Disaster Risks in Mega-Cities*. TERRAPUB Terra Scientific Publishing Company, Tokyo, 109-119.
17. van Langenhove, Berloznik, et al. (2002) Thinking, debating and shaping the future: Foresight for Europe. *Final report prepared by a High Level Expert Group for the European Commission*. 32 pp.
18. Weick, K. E. (1988) Enacted Sensemaking in Crisis Situations. *Journal of Management Studies*, 25(4), 305-317.