Disaster Risk Management and the Systems Approach

by Dr. Stephan Bieri

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0. Introduction

The management of risks is one of the great challenges of the 21st century. The ever growing human, economic and environmental losses due to natural and man-made disasters evidence the need for a systematic approach to the management of risks. The present contribution outlines the increasing complexity of every day life in general and of risk management in particular, and its relation to systems analysis. It is shown that a multi-disciplinary understanding of disaster risk management is required. The recently established World Institute for Disaster Risk Management (DRM), a network for applied research, implementation and dissemination in the field of disaster risk management, provides the framework for major contributions towards an integrated risk management and a sustainable risk prevention culture.

1. Starting point

Disaster risk management may be seen as a combination of traditional scientific and technical know-how and an appropriate method of decision-taking. There is a strong need for analysis, in theory and in practice, especially bringing together different interactions between man, nature, and society. Of course, there is always an important demand for engineering skills or management know-how. But the main question is not how to solve an isolated problem but how to control different interdependent actions. Thinking in complex systems starts at this point.

Let me begin with some fundamental remarks on risk, uncertainty, and choice:

> *„In the old days, the tools of farming, manufacture, business management, and communication were simple. Breakdowns were frequent, but repairs could be made without calling the plumber, the electrician, the computer scientist – or the accountants and the investment advisers. Today, the tools we use are complex, and breakdowns can be catastrophic, with far reaching consequences. We must be constantly aware of the likelihood of malfunctions and errors.*“ P.L. Bernstein (1996)

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2. Risk analysis and management

Risk and uncertainty relate to situations where there is *more than one possible outcome*. F. Knight (1921) first formally distinguished between risk and uncertainty:

> *Risk: We can identify the probability of each possible outcome.*
> *Uncertainty: We can identify the outcome, but not the corresponding probabilities.*

A special category is the unknown risks, consisting of situations where we neither are able to identify the possible outcome, nor, in consequence thereof, the corresponding probabilities of occurrence.

Risk in a project, in a program, or simply while pursuing a goal is a measure of the *inability* to achieve the objectives within cost, schedule, and the surrounding constraints. Risk can be defined as the product of the probability of a defined circumstance occurring and the consequence of the occurrence of said circumstance. From this definition it can be seen that assuming risk may well lead to both positive and negative outcomes.

Risk cannot be avoided as long as we do not know what the future holds. Risks also continuously evolve and change. Assuming and managing risk is the essence of any decision-making process. The proper management of risks is one of the biggest challenges that co-operation has to face today. Clearly, such a statement is as well valid for the world of science and of politics.

Risk management is a concept that may be implemented in various ways. All good risk management approaches include the following *characteristics*:

a) There is a planned and documented risk management process.

b) The process is based on a prospective assessment.

c) The assessment is periodically reviewed in order to validate the initial findings and to uncover new problem areas.

d) A defined set of evaluation criteria is applied in order to cover all aspects of the process.

e) The on-going results of the risk management process are formally documented.

The activities of the World Institute for Disaster Risk Management (DRM) should be based on this general framework, evolving from an abstract level to concrete sets of problems.

3. Systems analysis

As we know, the word system has many meanings, several without theoretical background. According to A. D. Hall (1962), a father of systems engineering, I propose the following definition:

A system is a set of objects with relationship between the objects and their attributes.

Objects are parts or components of a system, and attributes are properties of these. In my eyes, the most important step in defining a system is its relation towards environment (e.g. any social and natural environment):

For any system, the environment is the set of all objects outside this system.

In Linear Programming we try to confine the environment by a set of constraints. In planning theory, different sets of such constraints form scenarios. Formally, the attributes of the environment affect the system, whose attributes are changed.

Risks occur if we cannot control the relations within this system *and* if we don't know the impacts of changes in the environment. Coherence is needed, assuming and managing risks is the essence of the business decision-making process. One of the biggest challenges facing corporations today is the proper management of financial risks.

Disaster risk management should achieve a similar coherence in its specific environment.

I think, the risk of occurrence of natural and man-made disasters must be included in the consideration of economic, social, and political systems. All strategies to achieve better prevention or to limit impacts must be placed in such a framework. No doubt, there are a lot of useful ways repairing the world *after* damage. But if we want to do more we have to go beyond.

4. DRM and the mitigation circle

We are all too familiar with the recent natural disasters, such as earthquakes, floods, storms, avalanches, landslides, and fires. We want to create a network for applied research, implementation, and dissemination in the field of disaster risk management. The planned work should shift away from the *post-disaster response* towards an integrated risk management and sustainable risk prevention culture. Please note that the World Institute for Disaster Risk Management (DRM) wants to launch a substantial effort in the field of prevention.

Intervention and recovery measures are very well organised in most countries and we do not want to interfere with such established organisations. I am well aware that a large stock of techniques and practices are available. Yet I think that there is a lack on the prevention side, including land-use planning, technical measures, insurance as well as institutional conditions, e.g. competition policies.

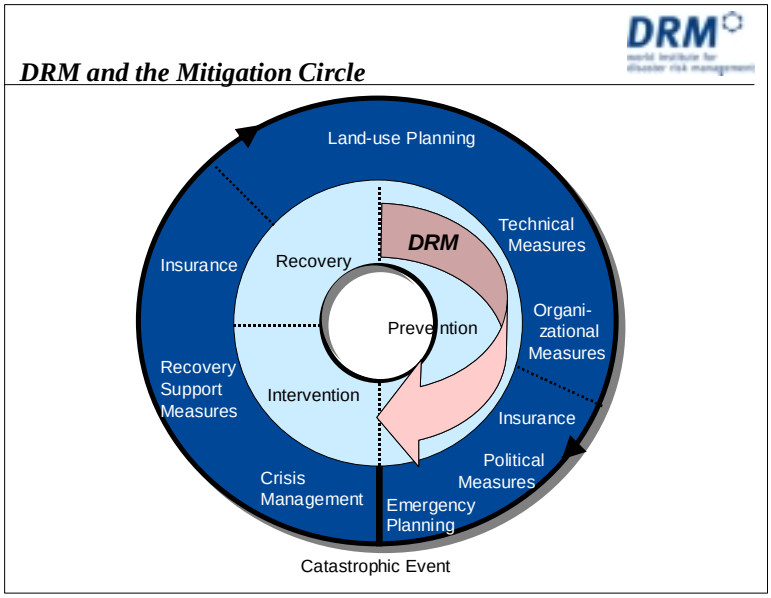

Figure 1: DRM and the Mitigation Circle

The main need is for the *integration* of sectoral results, the *modelling* multidisciplinary systems and for implementation-oriented approaches. Simulation can provide a better understanding. Such a procedure goes along with today's scientific methodology. For the last years, modelling and simulations were constantly growing fields due to the progress in

computer-based science. Integrated risk management techniques are increasingly becoming a tool in the day to day running of corporation. In my eyes, DRM should follow that track.

5. Application of the systems approach

The starting point of an integral risk management concept is the relation between hazard, vulnerability, risk and risk management. The approach of the World Institute for Disaster Risk Management (DRM) includes the *systems approach* (e.g. Wilhelm, 1999)*:*

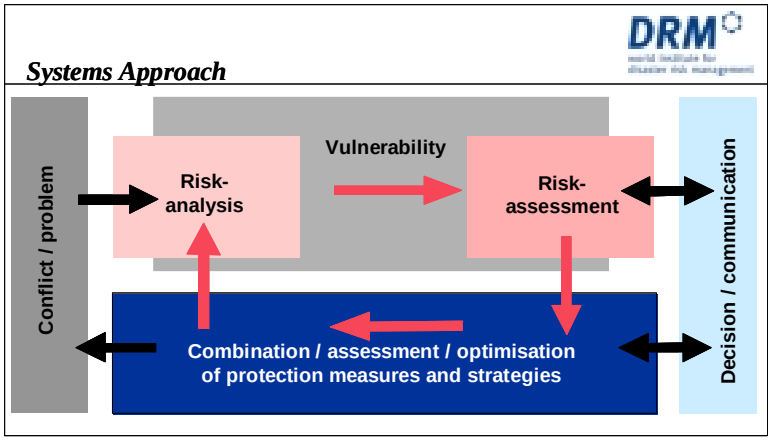

Figure 2: Systems Approach

The model links together the elements risk analysis, vulnerability, and risk assessment. It requires the *development of tools* for an overall risk mitigation. The development of methods and measures to support prevention and intervention activities such as monitoring, registration, forecasting, early warning, decision-supporting tools for frontline decisions becomes particularly important. The objective is to move away from scientific Taylorism.

Efficient risk management requires a careful evaluation of the *vulnerability* of the objects and of the systems at risk. Cost-benefit analyses of prevention measures can only be performed on the basis of a quantitative evaluation of possible damage to structures and entire systems.

Vulnerability is a concept still lacking clear scientific definition and theory that allows precise *quantification*. This is especially true of indirect damage costs, e.g. damage to society, loss of market share due to destruction of production facilities, and of cost estimates of damage to cultural heritage and to environmental systems.

Risk assessment consists of an enlarged method to understand the potential effects of natural hazards on human activities and on the environment. The main goal includes developing techniques that allow the most appropriate allocation of available resources in order to *optimise* the protection of a number of assets. This is a classical economic question.

Hazard assessment is based on the study of natural hazards interacting at different spatial and temporal levels, varying on the local, regional, and international scale. Individual hazards and physical processes have been studied individually. Today, this is the core activity of a great number of research institutes. *Therefore*, DRM supports the multidisciplinary understanding and integrated analyses of different processes. From there innovation should come.

6. Next steps

Following the systems approach and applying different sectoral research results, a first project portfolio for DRM has been developed. Special progress must be made in interdisciplinary co-operation.

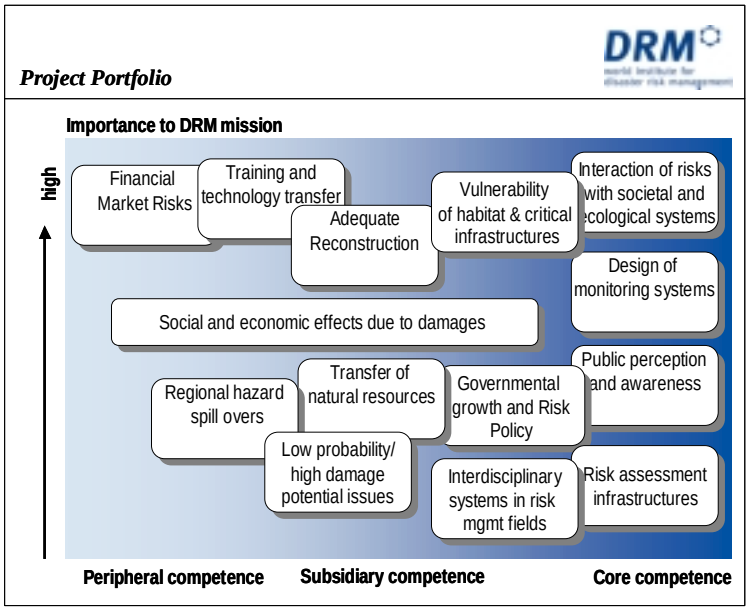

Figure 3: Project Portfolio

Theoretical work must be developed along two lines:

Firstly, we need better understanding of the fundamental relations between natural and man-made risks and the process of globalisation. I see especially three important fields in that context:

a) interdependence between disaster and economic development,

b) interdependence between disaster and sustainability,

c) interdependence between disaster and resource allocation (especially capital and technology).

Secondly, we have to deal with principles of welfare theory, such as discussing old fashioned criteria of interregional and intertemporal measures of government. This leads us to the recent controversy of the so-called precautionary principle (K. R. Foster, P. Vecchia, M. H. Rapacholi, 2000).

The more problem-oriented line approaches *institutional arrangements*. Different practices of tackling risks must be evaluated, namely changing from regulation to financial markets, or changing from competition policy to international co-operation. How far market mechanism works properly? What about deficiencies of legal framework and political force? Are international and supranational organisations able to promote long-term strategies of risk prevention?

All these questions bring us back to the welfare theory just mentioned. The “new economy” assumes a high degree of absence of excludability and absence of non-rivalry. In such context, we have to find arrangements protecting social overhead capital (e.g. communication infrastructure) and scarce natural resources.

I am not convinced that social policies promoting externalisation should be followed. After the Second World War German-speaking economists used the term “Ordnungspolitik” for an efficient systems approach of market economy. I very much believe that a robust framework for markets with little direct regulation offers best conditions for successful risk management of firms and individuals. So DRM can point out ways to avoid unnecessary government intervention and redistribution.

This will be a major reason for our direct collaboration with leading firms in different industries. Specific targets of DRM will be not only reinsurance, but also new financial products as well as specific ways of developing public infrastructure. Cutting-edge risk management of utilities or models of build-operate-transfer (BOT) include interesting interfaces for DRM.

References

- Bernstein P.L., 1996. Against the gods, New York: J. Wiley & Sons
- De Long J.B., Froomkin A. M., 1997. The next economy?, in: Hurley D., Kahin B., Varian H. (eds.), Internet Publishing and Beyond: The Economics of Digital Information and Intellectual Property, Cambridge: MIT Press
- Embrechts P., Klueppelberg C., Mikosch T., 1997. Modelling external events in insurance and finance, Berlin: Springer
- Foster K.R., Vecchia P., Rapacholi M.H., 2000. Science and the precautionary principle, Science, vol. 286, pp 979-980
- Hall A.D., 1973 (1962). Some fundamental concepts of systems engineering, in: Optner S.L. (ed.), Systems analysis, Harmondsworth: Penguin
- Knight F.H., 1964 (1921). Risk, uncertainty and profit, New York: Century Press
- Menheere S.C.M., Pollalis S.N., 1996. Build, operate, transfer, Delft: University of Technology
- Wilhelm C., 1999. Kosten-Wirksamkeit von Lawinenschutz-Massnahmen an Verkehrsachsen, Bern: Buwal