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Multi-hazard and multi-risk decision-support tools as a part of participatory risk governance: Feedback from civil protection stakeholders

Nadejda Komendantova [a,e,*], Roger Mrzyglocki [b], Arnaud Mignan [c], Bijan Khazai [d], Friedemann Wenzel [d], Anthony Patt [a,e], Kevin Fleming [f]

[a] International Institute for Applied Systems Analysis, Risk, Policy and Vulnerability Program (IIASA), Austria
[b] German Committee for Disaster Reduction (DKKV), Germany
[c] ETH Zurich, Swiss Seismological Service, Switzerland
[d] Karlsruhe Institute of Technology, Center for Disaster Management and Risk Reduction (CEDIM), Germany
[e] ETH Zürich, Department of Environmental Systems Science, Switzerland
[f] Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Section 2.1 Physics of Earthquakes and Volcanoes (GFZ), Germany

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ABSTRACT

The number of people affected by natural hazards is growing, as many regions of the world become subject to multiple hazards. Although volume of geophysical, sociological and economic knowledge is increasing, so are the losses from natural catastrophes. The slow transfer from theory to practice might lay in the difficulties of the communication process from science to policy-making, including perceptions by stakeholders from disaster mitigation practice regarding the usability of developed tools. As scientific evidence shows, decision-makers are faced with the challenge of not only mitigating against single hazards and risks, but also multiple risks, which must include the consideration of their interrelations. As the multi-hazard and risk concept is a relatively young area of natural risk governance, there are only a few multi-risk models and the experience of practitioners as to how to use these models is limited. To our knowledge, scientific literature on stakeholders′ perceptions of multi-risk models is lacking. In this article we identify perceptions of two decision-making tools, which involve multi-hazard and multi-risk. The first one is a generic, multi-risk framework based on the sequential Monte Carlo method to allow for a straightforward and flexible implementation of hazard interactions, which may occur in a complex system. The second is a decision-making tool that integrates direct input from stakeholders by attributing weights to different components and constructing risks ratings. Based on the feedback from stakeholders, we found that interest in multi-risk assessment is high but that its application remains hampered by the complexity of processes involved.

1. Introduction

Historical records show that economic losses from disasters have increased steadily from €150 billion (value inflation adjusted for the year 1999) for the period 1950–1959 to about €375 billion in the decade 1990–1999 [34]. Unfortunately, non-economic losses, such as human lives, are much more difficult to assess and they are not included in the majority of databases. Nonetheless, there is ample evidence in the literature that the number of people who are directly or indirectly affected by disasters will continue to increase [2,5,13,18,50]. Furthermore, many regions of

* Corresponding author.
E-mail address: komendan@iiasa.ac.at (N. Komendantova).

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the world are not subject to only single hazards, but may be impacted upon by multiple hazards, which may also be correlated. Conjoint disasters and cascading effects potentially yield higher direct losses, such as damage to infrastructure, as well as higher indirect losses, such as business interruption.

Existing risk assessment methods integrate large volumes of data and sophisticated analyses, as well as different approaches to risk quantification. However, the key question is why do losses from natural disasters continue to grow if our scientific knowledge on multi-risk increases? [48]. One reason is the increasing value of assets exposed to hazards. However, there may be other reasons, and an understanding of these will play a key role in the reduction of losses in the future. As Kappes et al. [26] stated in their review on multi-hazard risk, to be able to understand this question, we also need to examine the frameworks employed in the field of risk management, as well as the interactions between science and practice in terms of knowledge transfer and the applicability of results. The successful implementation of disaster risk reduction options and strategies demand not only comprehensive risk assessment schemes, but also an appropriate mechanism to communicate and transfer knowledge on risk and its underlying drivers to the various stakeholders involved in the decision-making process.

Multi-risk assessment tools have the potential to support decision-makers and to provide them with information on mitigation measures. These tools can influence the perceptions of stakeholders in terms of the probabilities of hazards and their impacts. But this is a double-sided communication process, as the feedback from stakeholders′ influences the usability of the tools and the implementation of recommendations provided by the geosciences, sociology and economics. That is why feedback and perceptions of the usability of these models from the side of stakeholders are extremely important to the process of communication from science to policy and vice versa. So far, however, the literature on the topic of how stakeholders perceive the usability of multi-risk models is very limited.

The aim of this paper is to identify the feedback of civil protection stakeholders to the value of two complementary decision-making tools developed within the context of the EU FP7 project New Multi-Hazard and Multi-Risk Assessment Methods for Europe (MATRIX1)[1]. MATRIX is setting out to methods and tools to tackle multi-type natural hazards within a common framework, focusing on the European context, which includes the following decision-making tools:

(1) A generic probabilistic framework that implements hazard correlations in a comprehensive manner [31], and
(2) An evaluation methodology based on the concept of the risk matrix to incorporate expert knowledge through stakeholder interactions into multi-hazard scenario development, developed by B. Khazai of the Karlsruhe Institute of Technology and described in this paper.

[1] http://matrix.gpi.kit.edu/index.php

This work is a first attempt to collect and to integrate the feedback of stakeholders from civil protection authorities into decision-making tools, which include aspects of multi-hazard and multi-risk. The feedback was gained during two workshops, in Bonn (July 2012) and in Lisbon (October 2012), and from questionnaires distributed on site at the first workshop. The research within this work encompasses three overarching questions:

a. How do stakeholders perceive multi-hazard and multi-risk situations and what are their requirements for multi-risk assessment tools?
b. How do stakeholders perceive the decision-making process for the mitigation of multi-risk and their feedback on the usability of decision-making tools?
c. Is there a difference in the resulting feedback from stakeholders (based on practice) and academia (based on more theoretical considerations)?

2. Background

This section aims at elaborating upon the basic terms in multi-risk assessment and examples of past experiences in multi-risk. This short review especially highlights the fact that decision-making under multi-risk is a nascent field. Feedback from stakeholders on newly developed multi-risk tools is a participatory process that is greatly needed to avoid a dichotomy arising between science and practice.

2.1. Definitions of multi-risk assessment

Risk assessment includes hazard assessment, followed by estimations of the vulnerability and values of the elements at risk (or exposure), all leading to the computation of risk as a function of hazard, vulnerability and exposure [45]. The term "natural hazard" refers to the "natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage" [43,46]. Risk is defined as the "expected losses of lives, persons injured, property damages and economic activities disrupted due to a particular hazard for a given area and reference period" [49]. Another definition of risk is "the combination of the probability of an event and its negative consequences" [43]. In any case, a definition of risk must also include the interaction of hazards and the vulnerability of the affected area, especially the built environment. Definitions developed by the European Commission extend the previous definitions by incorporating the terms "exposure" and "vulnerability" [9]. This foresees that an event of the same magnitude can have a different impact, depending upon the vulnerability and exposure of a given population and the associated elements, thus also involving the need to take into consideration preparedness and preventive measures. The definition of risk is also closely connected with the definition of uncertainty, as the term "probability" already itself implies aleatory uncertainties. Risk can also be understood as "the effects of uncertainty on objectives"