CHAPTER

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FROM MULTI-RISK ASSESSMENT TO MULTI-RISK GOVERNANCE:

Recommendations for Future Directions

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Introduction

Disasters caused by natural hazards can trigger chains of multiple natural and man-made hazardous events over different spatial and temporal scales. Multihazard and multi-risk assessment makes it possible to take into account various types of interactions between different risks. Classes of interactions include triggered events, cascade effects, and the rapid increase of vulnerability during successive hazards (see Marzocchi et al. 2012; Garcia-Aristizabal, Marzocchi, and Di Ruocco 2013).

Research carried out over the last decades has greatly increased the risk assessment community's understanding of interactions between risks. As a result of this new knowledge, several international documents, communications, recommendations, and sets of guidelines now advocate adopting an all-hazard approach to risk assessments (for example, see UNISDR [2005]; European Commission [2010a, 2010b]; for an overview, see Council of European Union [2009, section 2]). Indicator 3.3 of the Hyogo Framework for Action specifically promotes the "development and strengthening of research methods and tools for multi-risk assessments" (UNISDR 2005).

Nevertheless, barriers to the application of multi-risk assessment remain. The challenges for the development of multi-risk approaches are related not only to the applicability of results, but also to the link between risk assessment and decision making, the interactions between science and practice in terms of knowledge transfer, and more generally to the development of capacities at the local level. Scientific and institutional barriers to the approach, as well as the approach's benefits, need to be jointly investigated if it is to be implemented effectively.

This paper examines how to maximize the benefits arising from, and overcome the barriers to, the implementation of a multihazard and multi-risk assessment approach within current risk management regimes.1 Working at two test sites, one in Naples and one in Guadeloupe, the research team engaged in a continuous dialogue with local authorities and practitioners to better understand how to effectively implement the results of multi-risk assessment. Among the hazards considered were earthquakes, volcanic eruptions, landslides, floods, tsunamis, wildfires, cyclones, and marine inundation. Beside the practitioners working in the two test sites, risk and

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[1] The paper presents the results of interdisciplinary research undertaken within the framework of the MATRIX (New Multi-HAzard and MulTi-RIsK Assessment MethodS for Europe) project. The research was supported by the European Community's Seventh Framework Programme through the grant to the budget of the MATRIX project (New methodologies for multihazard and multi-risk assessment methods for Europe [FP7/2007-2013]) under grant agreement no. 265138. The paper reflects the authors' views and not those of the European Community. Neither the European Community nor any member of the MATRIX Consortium is liable for any use of the information in this paper. We wish to thank all who offered professional advice and collaboration. We are especially grateful to the practitioners who discussed with us the challenges of multi-risk assessment.

emergency managers from 11 countries also provided feedback based on lessons learned in other case studies. In total, more than 70 practitioners took part in the research.

Multi-Risk Assessment: General Overview

This section summarizes some general concepts related to multi-risk assessment.

In spite of growing interest in and use of multi-risk assessment approaches, devising an integrated multi-risk assessment scheme remains a major challenge. It implies adopting a quite different perspective from that of classical single-risk analysis. Considering the general definition of multi-risk provided in the European Commission working paper on risk assessment and mapping guidelines for disaster management, the kind of events considered in a multi-risk analysis may include two different sets of events: events threatening the same elements at risk without chronological coincidence, or events occurring at the same time or shortly following each other—whether independently, or because they are dependent upon one another, or because they are caused by the same triggering event or hazard (European Commission 2010b). The first case represents what is generally termed "multihazard risk," whereas the second case represents the possible interactions that are one of the characteristic elements of a full multi-risk assessment.

The results provided by a full multi-risk approach are the harmonized quantitative assessment of the different risks and the effects of the possible interactions. Thus a multi-risk assessment may make it possible to establish a hierarchy of risks, but it can also be used to identify areas where efforts to mitigate one hazard may conflict with, or create synergies with, the response of the system to a second type of hazard, or even with planned adaptation and mitigation activities for other hazards (that is, may potentially increase or decrease the risk from other hazards).

So far, research has focused on the scientific rather than the institutional aspects, such as the issues arising when multi-risk assessment results need to be implemented into existing risk management regimes. In general, natural hazard research has not devoted much attention to the institutional context of disasters, including a variety of elements ranging from sociopolitical to governance components (Scolobig et al. 2013). It is these aspects that our research has focused on.

Research Design

Our research design aimed to encourage interaction between researchers and practitioners/decision makers and included a wide array of methods and tools, such as interviews, questionnaire surveys, workshops, and focus groups. The research started with a policy/institutional analysis—that is, desk studies of legal, regulatory, and policy documents—to provide a description of the institutional and regulatory framework for risk governance within different natural hazard contexts and countries.

To identify the barriers to effective decision making in the case of multiple hazards, we first engaged practitioners in interviews and focus group discussions. In parallel, we performed multi-risk assessments of some specific scenarios at the two test sites. We presented the results during three workshops with practitioners, where we also discussed the barriers to and benefits of implementing multi-risk assessments. Table 1 summarizes the key research phases, the methods employed, and the accompanying aims.

Table 1. Research Phases

Research phase	Methods	Aims
Institutional/policy analysis	Desk study of legal, regulatory, and policy documents (Naples and Guadeloupe)	To provide a description of the institutional and regulatory framework for risk governance within different natural hazard contexts To identify comparable sets of governance characteristics across hazards and countries
Interviews and focus groups	Semistructured and in-depth interviews; focus group with a total of 44 participants (Naples and Guadeloupe)	To identify the social and institutional barriers to effective decision making in the case of multiple hazards To propose initial options for overcoming multiple hazards To provide feedback on the results of the institutional analysis
Workshops	Three interdisciplinary workshops with participants from 11 countries (Italy, France, Norway, Germany, Hungary, Bulgaria, Sweden, United Kingdom, Iceland, Croatia, Austria) • Naples (20 participants) • Guadeloupe (32 participants) • Bonn (21 participants)	To present the new multihazard and multi-risk assessments and scenarios developed within the MATRIX project[a] To discuss the barriers to and benefits of implementing multi-risk assessment in the test sites and receive feedback from a wider audience in order to identify results applicable to other multi-risk environments
Feedback	In-depth interviews with and questionnaires submitted to workshop participants (Naples and Guadeloupe)	To collect feedback on the workshops' results To collect feedback on the recommendations for decision support developed by the research team in the previous research phases

a. For more on the MATRIX project, see footnote 1 above.

As mentioned above, most of the research was conducted for two test sites: Naples and Guadeloupe. With a population of 962,000,[2] Naples is the biggest municipality in southern Italy and is the capital of Campania, one of Italy's 20 regions. The city has a widely recognized high volcanic hazard and is also exposed to earthquakes, floods, landslides, and fires. Most of these hazards are interconnected.

The French overseas department of Guadeloupe (Département-Région d'Outre Mer) is exposed to similar types of hazards, although it is also prone to high cyclonic (hurricane) risk and tropical storms, and is less exposed to fires. Guadeloupe is located in the Lesser Antilles and includes five main islands covering an area of 1,628 km^2. The archipelago has 32 municipalities and 403,000 habitants.[3] The major geological risk in Guadeloupe is posed by the active volcano of la Soufrière and by the seismic activity along the inner Caribbean arc, both of which can trigger tsunamis and landslides.

Both Naples and Guadeloupe have established plans and undertaken projects intended to protect their citizens from the multiple risks described above, and both have deployed scientists, engineers, and policy makers to reduce risk and vulnerability. Moreover, in both test sites multi-risk assessment has been performed. In Naples, two scenarios of risk interactions were considered for quantitative analysis: the effect (on seismic hazard and risk) of seismic swarms triggered by volcanic activity, and the cumulative effect of volcanic ash and seismic loads. Both cases can be combined into a single scenario of interactions at the hazard and the vulnerability level; the combination highlights the different aspects of risk amplification detected by the multi-risk analysis (Garcia-Aristizabal, Marzocchi, and Di Ruocco 2013).

In Guadeloupe, researchers conducted a scenario analysis of cascade effects and systemic risk. Following a deterministic approach, the analysis considered interaction between earthquake and landslide phenomena, along with its consequences on the local road network in Guadeloupe and the transport of injured people to hospitals and clinics (Monfort and Lecacheux 2013).

Results

A first (and expected) finding is that risk and emergency managers hardly ever have the opportunity to deal with multi-risk issues, including triggered events, cascade effects, and the rapid increase of vulnerability during successive hazards. Moreover, multi-risk assessments for

[2] The figure is from the 2011 INSTAT (Italian National Institute of Statistics) census.

[3] The population figure is from the 2010 INSEE (National Institute of Statistics and Economic Studies) census.

different scenarios are at present rarely performed by practitioners at both the national and local levels.

A second finding is that most of the participants saw the benefits of including a multi-risk approach in their everyday activities, especially in land-use planning, as well as in emergency management and risk mitigation.

Benefits

Among the benefits of a multi-risk approach considered particularly crucial by practitioners are the following: improvements in land-use planning, enhanced response capacity, the identification of priorities for mitigation actions, and enhanced levels of risk awareness and cooperation.

Improvement in land-use planning

Practitioners believe that a multi-risk approach is particularly useful for gaining a holistic view of the risks affecting a territory and is appropriate in all geographic areas susceptible to several types of hazards. They also wish there were clear criteria for determining which scenarios would be most appropriate for a multi-risk assessment.

The results of a multi-risk assessment should be considered for urban planning, especially in relation to decisions on building restrictions in risky areas. Landslide hazard and risk mapping, for example, may not address the specific effects of different possible triggering events (intense rainfall, earthquakes, etc.). In the case of Naples, a detailed map with the areas susceptible to landslides is available, but it does not include information about (for instance) the possible short-term effects of volcanic eruptions. But an eruption of a volcano in the area could produce unstable ash-fall deposits (even in low-susceptibility areas) that afterward contribute to the generation of lahars (mud flows) triggered by rainfall events. Thus multi-risk scenarios are highly appropriate in land-use planning.

Urban planners especially emphasized how the multi-risk assessment could influence decisions about building restrictions, which themselves influence urban and economic planning—for example, by permitting or forbidding construction of new houses and/or economic activities. The adoption of a multi-risk approach can therefore indirectly influence urban and economic development and touch upon delicate public and private economic interests.

Enhanced response capacity

Practitioners believe that emergency management would greatly benefit from adopting a multihazard and multi-risk approach. Civil protection managers were especially interested in developing multihazard and multi-risk scenarios to facilitate management of emergency situations in real time (Monfort and Lecacheux 2013). In the Guadeloupe case, for example, evidence suggests that failure to consider cascade effects (earthquake-landslide interactions) and to employ a systemic approach may result in gross underestimation of risk. The work

undertaken in Guadeloupe considered the interaction between earthquake and landslide phenomena and its consequences for road networks and the removal of injured people to medical facilities. A landslide triggered by an earthquake in the northwest of Basse-Terre might cut off a main east-west road, one critical for moving the injured to hospitals and clinics. Damage to some lifelines (water, electricity) was also taken into account. The final results of the scenario determined realistic times required for the evacuation of the injured, either considering or not considering the damage to the road network and the connectivity to lifelines of the hospitals (Desramaut 2013; Monfort et al. 2013).

Identification of priorities for mitigation actions

The quantified comparison of risks that would allow a multi-risk approach was also seen as a benefit. Quantified comparison is particularly useful for identifying priorities for actions—an especially difficult task for policy makers, who generally rely on assessments that do not take cascade and conjoint effects into account. The quantified comparison of risks has policy implications for the planning of mitigation actions. It can show, for example, that prioritizing a particular hazard may mean giving insufficient weight to other hazards, and that mitigation measures against a prioritized hazard could actually increase the area's vulnerability to a different hazard. This point was of particular concern to practitioners working in municipal technical offices (see also Otani [1999]).

Enhanced levels of risk awareness and cooperation

Multi-risk assessment can help to increase a population's awareness of natural risks, of multi-risk, and of associated cascade effects. Practitioners in Guadeloupe working for municipal authorities noted that the local population is aware of different risks to different degrees, probably because of the intensity and recurrence of specific events and their consequences for human assets. While the culture of primary risks, such as cyclones, earthquakes, and volcanoes, is well established in Guadeloupe, the culture of secondary risks, such as tsunamis, landslides, marine and inland floods, and coastal and slope erosion, is less established. Practitioners from other countries indicated that communicating the results of multi-risk assessment to the general population would help to increase awareness of secondary risk.

A multi-risk approach can also enhance cooperation and foster needed partnerships between policy makers, private sector actors, and scientists. One key to promoting such partnerships is to establish a common understanding of what multi-risk assessment is, what the preferences and needs of practitioners are, and what the implications for regulatory instruments (related for example to urban planning) may be. Interviewees and workshop participants, especially from the private sector, cited the importance of partnerships between insurers and policy makers in using improved risk information for the development of risk financing schemes that cover large losses after multihazard catastrophic events.

Barriers

Barriers to an effective implementation of multi-risk assessment are found in both the science and practice domains.

Science domain

A major barrier to implementing multi-risk assessment involves differences between the geological and meteorological sciences and the research carried out under their auspices. These differences extend to concept definitions, databases, methodologies, classification of the risk levels and uncertainties in the quantification process, and more. Thus each type of risk has its own scale or unit of measure for quantifying risk or damages (e.g., damage states for seismic risk and loss ratios for floods). These differences may make it harder for the various risk communities to share results and may represent a barrier to dialogue on multi-risk assessment. This does not mean that single-risk-centered approaches should no longer be pursued; practitioners and researchers alike agree that the two approaches can coexist. The results of the desk studies made clear that basic knowledge about many risks is still incomplete—and the advances in knowledge about specific risks gained from single-risk assessments will also be useful for multi-risk assessments.

A barrier that is more worrying for risk managers than for researchers is the lack of open access to risk and hazard databases, the lack of tools for sharing knowledge, and the difficulties associated with accessing new research results. According to a practitioner working for a meteorological service, "The researchers want to keep the data because they want to publish." Another practitioner stated: "Private companies and research institutions often do not make their data available because it is for the benefit of their competitiveness." There are a number of reasons that practitioners may not have access to or consult new research results: they may lack time or necessary experience, may be hampered by language issues (research results are often published in English), or may simply lack interest or motivation. As might be expected, scientists view the matter differently and maintain that research results are freely available online. The same is not true for the databases, however, although the reason for this is simple: most practitioners do not know how to use them. The issue, then, is not whether data are available, but who uses and interprets the data and for what purpose—or more fundamentally, who is able to access and present information in a meaningful and useful manner. Scientists maintain that data collected by private actors (such as private consultants or insurers) are often not available to them, or that these data are not collected systematically and thus cannot be used for scientific purposes.

Practitioners and researchers also have different views about the preferred agenda for future research on multi-risk assessment. Researchers working on the technical/scientific aspects would seek to improve knowledge of the physical processes and models related especially to cascade effects; harmonize terminology and databases; make uncertainty assessment a focus; combine single-risk analyses into integrated multi-risk analyses; integrate the results of multi-risk assessment into existing emergency scenarios and capture cascading effects in probabilistic

terms; and conduct multi-vulnerability assessment. Practitioners would prioritize collecting evidence about lives and property saved using a multi- versus a single-risk approach, gaining an overview of multi-risk contexts at the town level, and especially learning to use and integrate new research results in existing emergency and urban plans. Depending on the practitioners themselves (risk versus emergency managers, regional officers, insurers, etc.), the needs and expectations could vary extensively.

Practice domain

The deep differences in the approaches, tools, and methodologies used for single-risk assessment have resulted in a lack of integrated practices for multi-risk governance. Especially where risks are managed by authorities acting at different governmental levels, cooperation among institutions and personnel is a challenge. The priorities of the various agencies vary extensively, and there may be insufficient financial capacity to cover them all. In some cases a multi-risk approach is perceived as competing with (rather than complementing) single-risk approaches.

Capacities, mainly financial, but sometimes also technical and institutional, are especially lacking at the local level, even though responsibility for disaster risk management often falls to local authorities or private actors. The transfer of responsibility for disaster risk reduction to the local level (to the municipal level in many European countries) has often occurred without sufficient resources for implementing necessary programs (UNISDR 2005, 2013). Private actors, especially property owners, are being given increasing risk-related responsibilities, which—depending upon the risk, the country, and the availability of insurance schemes—may differ. Different levels of responsibility are attributed to property owners in geological versus meteorological risk prevention, for example. In the case of earthquakes, the level of individual responsibility is high (given that property owners are usually in charge of household vulnerability reduction measures). In the case of floods, public authorities have responsibility for decisions about risk mitigation measures, such as protection works or depolderization efforts, and the costs are covered collectively. In general, there are few options for public-private responsibility sharing, especially for households exposed to multiple risks (and especially where insurance schemes are not available, as is the case in some European countries).

Recommendations for Future Directions

Our results show that a multi-risk approach is considered particularly useful for improving land-use planning and for gaining a holistic view of all possible risks that may affect a region. Such an approach can show, for example, that focusing on the impacts of one hazard may mean disregarding the effects of other kinds of events, and that efforts to mitigate that specific hazard could increase the area's vulnerability to another type of hazard. Other benefits of the approach particularly valued by practitioners include enhanced response capacity, cost reductions, improvements in the efficiency of proposed risk mitigation actions, awareness of the possibility that expected losses will be exceeded (that is, an understanding that the total risk

may be greater than the sum of the individual parts), the development of new partnerships between agencies working on different types of risks, and higher levels of risk awareness. Our results also show that barriers to an effective implementation of multi-risk assessment are present in both the science and practice domains. These barriers provide the background for the following recommendations for future directions, good practices to make multi-risk assessment implementation more effective, and insights into how local capacities may be strengthened within multi-risk environments.

Creation of Multi-Risk Platforms

Researchers, research-funding institutions, and public/private authorities responsible for carrying out risk analysis should make their databases and results available online. They should also make them user-friendly and suitable for a variety of users; at least they should specify a difference between documents for the general public and practitioners. Special attention should be devoted to the development of territorial databases collecting information about multihazards. These databases should include demographic data, economic data on public and private dwellings, data on roads and other lifelines, data on agriculture, and data on the environmental value of ecosystems and natural spaces. These data would allow for more integrated assessment of potential or real damage in relation to single or multiple hazards. To help practitioners understand where it is worthwhile to invest their limited resources, criteria should be established for determining which scenarios are good candidates for multi-risk assessment.

Creation of Local Multi-Risk Commissions

Authorities at the national or local level should support the creation of local multi-risk commissions—that is, institutional arenas with an interdisciplinary and multisector character for discussing and acting on multi-risk issues. Members of these commissions should include experts/researchers with experience in multi-risk assessment and backgrounds in different risk areas (meteorological, geological, and technological), local risk/emergency managers and practitioners, and local natural hazard advisors who would act as the liaison between local communities and practitioners.[4] With this type of membership, local multi-risk commissions could act as a bridge between research and practice, simplifying complex information related to multi-risk assessment, establishing a common conception of what multi-risk assessment is, encouraging knowledge exchange, and so on. Once a common background was in place, the commissions could perform a range of functions, such as provide suggestions for the elaboration of risk maps and for urban planning, discuss priorities for future research on multi-

[4] Commissions including local natural hazard advisors have already been created in some countries, including Switzerland, but they do not have a multi-risk dimension.

risk, encourage the development of local capacities, and develop educational and training activities.

In conclusion, our research shows that the best chances for innovation, in research and policy, reside in integration and collaboration. Technical and institutional capacities should be jointly and harmoniously developed in order to guarantee a better use of new scientific knowledge in developing policies and practices on multi-risk assessment.

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