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Risk Research ENSUREing to MOVEahead

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Risk Research
ENSUREingto MOVEahead

A cooperative paper based on the results of the projects ENSURE and MOVE

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Enhancing resilience of communities and territories facing natural and na-tech hazards / www.ensureproject.eu

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The contributors have attempted to present and reflect on the objectives, activities and results of the respective projects in consensus with the whole consortium.

Introduction

The term 'vulnerability' has become a key concept in disaster research and management due to the influence that the vulnerability of objects, populations and systems has on the extent of damage and losses considering all kind of calamities (natural, socio-natural or entirely man-made). Despite the fact that 'vulnerability' is construed in various ways by experts and stakeholders from different fields and backgrounds, one may describe vulnerability as the degree of susceptibility or fragility of communities, systems or elements at risk and their capacity to cope under adverse or hazardous conditions.

The importance of vulnerability is underlined by the fact that the impact and scale of a hazardous event is largely determined by human factors. That is, the hazardous event itself might be purely 'natural'; any disastrous impact, however, is in addition strongly influenced by the social, political, economic and environmental setting. Furthermore, adverse effects of such events often segregate societies or populations of an affected region by social class, ethnic groups, health, age or gender. A well-known example is that of hurricane Katrina causing disproportionally high number of victims amongst the poor black and elderly population in New Orleans in 2005 (Cutter et al., 2006).

Against this background it is increasingly accepted that building resilience and reducing vulnerability are key factors in risk reduction. This is particularly important as societies are currently being forced to adapt to new and unknown stressors and pressures triggered by global changes that are hard to predict and may influence all parts of society including the economy, environment and climate.

Within this context it can be said that there is a shared consensus that policies need to place an emphasis on prevention through a more comprehensive, integrated risk assessment. In this framework, risk management strategies must evolve from focusing on disaster events and defence against risks to a broader strategy based on reducing vulnerability and increasing resilience (Medd and Marvin, 2005). This is in contrast to the way risks have been handled in the past, where the focus has

been mainly on post-event disaster response, rescue and recovery. The major uncertainties involved in understanding the complex dynamics of natural systems, climate change and extreme events are among reasons for such evolution in risk mitigation strategies.

Risk assessment and risk management cannot be separated. The way risk assessment is framed significantly affects the kind of mitigation measures that can be designed. When only the hazard component is considered, the response will be largely limited to structural measures to diminish the severity and/or frequency of potentially damaging events; adding the exposure component, will improve the risk management, but strategies will merely focus on reducing numbers and assets at risk. By adding the vulnerability and the resilience components, a distinction among equally exposed elements and social groups can be made, identifying those that are more or less likely to suffer from damage because of their intrinsic characteristics.

'MOVE' and 'ENSURE' are two projects that have been funded within the European Commission's FP7. They both focused on vulnerability and explored ways of enhancing the capacity of assessing vulnerability, and suggesting ways of improving its inclusion in scenario modelling and risk analysis. Both have developed frameworks and methods that have been a) tested in case studies and b) presented to stakeholders in order to obtain their opinion about the practical viability and potential use of the framework and methods in policies and administrative processes.

This paper is a joint effort made at the end of the two projects' activities in order to share common results with the wider scientific and decision making communities. It intends to support relevant European policies and to contribute to the discussion of future research, particularly within the context of risk caused by hazards and environmental change.

1.
Relevant policies and programmes

The final target of vulnerability research within the context of risk assessment approaches is to reduce the adverse impact of potentially damaging future events on society. To achieve this it needs to contribute to the improvement of how society governs and manages risk. Risk governance is a complex task due to the wide variety of actors involved at all decision-making levels; complicated cause-effect relationships; the high level of uncertainty regarding scientific models; and the transdisciplinary character of mitigation and adaptation strategies.

Risks originating from natural and man-made hazards have been correctly labelled by Huber (1995) as collective risks, for which several layers of multiple responsibilities have to be considered. This means that several levels of government (from local to national and sometimes beyond), agencies, and public and private organisations (including citizens), hold some degree of responsibility in shaping risk factors. Therefore, a shared responsibility approach has to be taken in managing such risks (May and Williams, 1986). However, such an approach conflicts with how risk aspects are generally managed and dealt with - both relating to policy and science.
Concerning science, Stirling (2007), building on previous work by Renn (1995), establishes a further subtle difference between uncertainty and ambiguity. Attempts to model risk are challenging not only because of intrinsic uncertainties, but also due to fundamental ignorance about relevant aspects of how potentially hazardous events interact with complex systems. Furthermore, as discussed by Beck (1992), decisions relating to risk thresholds are ambiguous, in that they are not purely technical, as risks themselves imply a blend of "facts" and "values" that cannot be separated from one another. In their work, Salter (1998), Sarewitz et al. (2000), and Jasanoff (1990), all pointed out the dangers stemming from the interaction between different types of uncertainty, whenever regulations and decisions need to be made. Reflection on uncertainties at different levels and on the interaction between social groups,

including scientists, and stakeholders deserves perhaps further efforts, particularly in the light of the pertinent report "Taking European Knowledge Society seriously" (EU Commission, 2007).
Concerning policy, Handmer (1999) noticed that the need to make sound decisions regarding issues that by their nature are transversal to governmental sectors (and risk governance is a perfect example), strongly conflicts with the way modern states work. Sectorialization of practices and separation of power imply poor coordination between authorities and agencies that should be focusing on common goals. Also, crucial information is often kept by individual organizations, and does not flow between the different offices and administration bodies.

Accordingly, one of the most relevant findings of both the MOVE and ENSURE projects has been that vulnerability cannot be easily isolated or treated separately at individual levels or sectors. This is because it results from a process that is shaped over time and across a variety of scales, as well as involving multi-layered decision-making processes. For example, a low number of earthquake resistant buildings in a seismic zone may be a result of a lack of policies for retrofitting buildings at national level. However, it may in addition stem from institutional weaknesses relating to (non) compliance with building construction regulations.

Probably the general lack of legislative tools to reduce natural hazard risk in the EU is partly a consequence of the complexity of the risk governance aspect. The Floods Directive adopted by the European Commission in 2007 represents a notable exception to this judicial gap. Member States have been asked to develop flood risk assessment and maps to support flood risk management plans in a recurring effort. A first round of risk management plans is set for 2015, but it is already clear that this only constitutes a first step towards enhanced assessment and mapping methodologies, which will then be applied in order to support a second stage planning effort for 2021. The MOVE and ENSURE projects provide significant support in developing the type of analysis required by the Flood Directive. For example, the nature of results seen up until now (in the Danube catchment and in Italy for example)

suggests that there is significant room for improvement by taking into consideration vulnerability factors beyond simple exposure to flood hazard.

1.1. Resilience, adaptation and response in a changing environment

Part of such a holistic, integrated risk approach is to strengthen resilience responses to hazardous events through adequate prevention measures. Resilience does not just signify returning to a pre-event condition, which may have been a weak and therefore undesirable one, but rather to transform a crisis into an opportunity for enhancement and improvement and thus the reduction of pre-event vulnerability.
The Hyogo Framework of Action (UNISDR, 2010) adopted by the European Union and the Council of Europe's 2011 report on "Governance of Climate Change Adaptation" call explicitly for an increase in the resilience of societies affected by natural hazards and their impact.

The cross-scale temporal relationship mentioned above is particularly relevant when tackling the link between what is done before and after the natural hazard impact, including the later phases of recovery and reconstruction. Being prepared for recovery or having ideas about how to reduce vulnerability in a city, a region, an enterprise or a system is crucial in order to not only adjust to change, but also to do so in the best possible manner. At the same time this should allow for the process of learning from the crisis itself. However, only well-organized and well-prepared agencies (or 'societies') are able to learn as well as correct fundamental errors, even when these require the revision of deeply rooted assumptions and cultural behaviour (see Roux-Dufort, 2000). This process of learning and adaptation by understanding first the correlation between different types of damage as well as different types of vulnerability is essential, as shown in the various case and test study areas analysed within the ENSURE and MOVE projects.

This is particularly relevant for the condition of climate change, in which predictions tainted largely by uncertainties do not guarantee that previous methods of preparation will be successful. Concerning hydro-meteorological hazards, the white paper on "Adapting to Climate Change: Towards a European Framework for Action" (EC Com, 2009) establishes a framework for reducing the vulnerability of the EU to the impact of climate change. It is based on a wide consultation launched in 2007 by the "Green Paper on Adapting to Climate Change in Europe", and research efforts that identified actions to be taken in the short term. It will complement action by Member States and support wider international efforts to adapt to climate change, particularly in developing countries. The European Commission is examining ways to improve the monitoring of natural hazard impacts and adaptation measures to develop vulnerability indicators e.g. through climate change vulnerability and adaptation indicators (ETC/ACC Technical Paper, 2012). The two projects MOVE and ENSURE have pursued an iterative diagnostic approach to vulnerability assessment, building on theoretical advancement in the field of climate change, which requires the full acknowledgment of the dynamic process of adaptation (and maladaptation) to stressors. Such an iterative approach is inevitable in a changing environment (built as well as natural), where assessments have to feedback and assist in monitoring the effects of decisions.

1.2. Including vulnerability in risk mapping efforts

As for pre-event scenario and risk assessment, in November 2009 the Council of the European Union adopted "Conclusions on a Community Framework in Disaster Prevention within the EU" (EC, 2009), stressing hazard identification and risk analysis, impact analysis, risk assessment and matrices, scenario development, risk management measures and regular reviews as important components of the EU disaster prevention framework and

of prevention policies at all levels of government. They also highlighted the potential for added value of EU work in these areas.
The conclusions list the initial actions that should be taken by the European Commission over the following years. Based on these findings, several activities have begun, including efforts carried out by the DG Humanitarian Aid and Civil Protection to establish a set of guidelines entitled "Staff Working Paper on Risk Assessment and Mapping Guidelines" for disaster management, drafted in December 2010. These guidelines are based on the experience of practical applications of national risk assessments and mapping, in particular pre-existing good practice risk assessments of major natural and man-made disasters available in Member States. They are clearly aimed at improving comparability of risk assessments and scenarios developed by individual countries. The guidelines take full account of existing EU legislation including the directives on flood risks, protection of European Critical Infrastructures, the control of major accident hazards (Seveso), and the Water Framework Directive (including provisions for drought management). Within the guidelines, vulnerability enters in the identification of the second procedural step, which is the risk analysis. The results of the MOVE and ENSURE projects provide a useful contribution concerning how to enhance current practices of vulnerability assessment that are shortly listed in the document.

1.3. Sustainable risk mitigation, sustainable development

The concepts of vulnerability, resilience, risk mitigation and sustainable development are closely interlinked, as the topic has already been raised and discussed in literature (see Menoni and Margottini (eds.), 2011). However, a deeper reflection should be made concerning possible cross links between vulnerability and sustainability indicators (Winograd, 2007). This would reinforce the

idea that vulnerability reduction and sustainability share many common issues, which should be considered as priority hotspots when developing common strategies in order to achieve a more sustainable and less vulnerable environment. Nevertheless, the two concepts are not totally overlapping (in the same way as resilience, coping capacity and other theoretical concepts are similar but still have essential differences) and therefore some care should be deployed in the way plans and programs seek to improve society and activity footprints on nature, while making them more resilient to natural extremes.

Current efforts at European level to tackle issues of risk and sustainability are predominantly sectorised. Even, the ambitious and remarkable Council Conclusions on a Community framework on disaster prevention within the EU taken during the 2979th JUSTICE and HOME AFFAIRS Council meeting held in Brussels on 30 November 2009 does not refer explicitly to the relation between a risk reduction strategy and the sustainable development of European countries.

Recently, the Third Global Platform called on participants to support implementation of the Millennium Development Goals (MDGs) and sustainable development by promoting risk reduction strategies that protect development investments. This was also reflected in several of the outcomes from Regional Platforms and Ministerial Conferences for Disaster Risk Reduction held in 2010-2011 in Africa, the Americas, Asia and the Pacific, the Arab States and Europe.

Foto 1. Vulcano Island

1.4. Relevance of vulnerability assessment in protection programs of critical infrastructures

The Green Paper on a European Programme for Critical Infrastructure Protection (EPCIP) adopted in 2005 has provided policy options on how the Commission could establish this program as well as how to establish a Critical Infrastructure Warning Information Network (CIWIN). The overall objective of EPCIP is to improve the protection of critical infrastructures in the EU following an all-hazards approach. The European Critical Infrastructures are those designated as being of utmost importance for the European Community and the disruption or destruction of which would affect two or more Member States or a single Member State if the critical infrastructure is located in another member State. This includes cross-border effects resulting from the interdependence between the interconnected infrastructures in various sectors. The procedure for the identification and designation of European Critical Infrastructures (ECI), and a common approach to needs assessment in order to improve the protection of such infrastructure, will be established through a Directive. The implementation of EPCIP includes the establishment of expert groups at EU level, which will be in charge of identifying vulnerability, interdependency and sectorial best practices; assisting in the development of measures aimed at reducing and/or eliminating significant areas of vulnerability; and the development of performance indicators. In response to this the ENSURE project has put particular emphasis on critical infrastructures, for which a specific section in each evaluation matrix has been prepared. Indicators build on previous relevant work also carried out under the EU Commission auspices (see Kyriakopoulos and Wilikens, 2001).

1.5.
Relevance of vulnerability assessment in protection programs of historic heritage

In Europe, a large sector requiring protection is pre-existing urban areas, some of which also hold relevant historic and cultural value. Understanding the vulnerability of such cultural heritage has been a concern of international agencies such as Unesco (see the campaign Cultural Heritage at Risk). However, this is also a relevant issue raised by the Flood Directive, which mentions explicitly cultural heritage as one of four strategic assets, together with economic activities, human health and the environment, to be protected against floods. In this regard, the ENSURE project has provided examples of indicators that can be used for heritage settings in order to assess the vulnerability of both historic buildings and ancient urban fabrics to earthquakes, floods, and volcanic eruptions.

1.6.
The evident / obvious and hidden costs of vulnerability

The "expected damage" as a critically important variable in the determination of risk, is the result of the combination of the severity of the hazard and the response capacity of exposed systems and elements of these systems. As both the MOVE and ENSURE projects showed, current capacity to estimate the aptitude in responding to a given hazard is limited, and current procedures and policies are not helping to improve this situation. First, there is a tremendous gap in damage accountability. At the global scale, damage reporting databases available for the EU are not designed to support an enhanced understanding of how and why losses occur after the impact of a given natural extreme. At the national and sub-national level, databases are made for strict administrative purposes (for example to specify

compensation values), whilst very little is done to keep a record of the wider impact. While global databases are often lacking important information (for example helping to geo-reference the event's exact impact), national and sub-national databases respond to different entry criteria and their use for developing a wider European picture is not possible. A better damage accounting model would ease reconstruction, permitting a much more purposeful prioritization of resources and funds, and would provide a much sounder basis for developing more reliable scenarios of expected impact.

Developing better tools for investigating post disaster damage requires a sound understanding of the kind of consequences and impacts that such events may have, and therefore also of the areas where direct damage is more likely to be devastating, for example, as a consequence of the density of population and value of exposed assets. Indirect and secondary damages would be better understood if vulnerability characteristics other than physical, i.e. social, economic and systemic were more carefully addressed. The limits of current tools used to appraise the consequences of disasters also negatively influence the capacity to forecast future expected damage due to natural extremes and to climate change. A more careful damage analysis would raise the question of whether or not vulnerability of a system can be considered a cost per se. It can be seen as a hidden cost that becomes manifest only after an event stresses vulnerable components of that system, but also as a present cost, given that vulnerable assets are often less efficient and effective in providing services also in normal conditions. In fact, many parameters identified by MOVE and ENSURE for vulnerability assessment pinpoint the existing, current level of operationality and quality of existing goods or services.

Vulnerability assessment as a tool for estimating climate adaptation capacity is a key issue listed in the Climate-Adapt platform. This platform is a collaborative initiative between the European Commission and the European Environmental Agency, aimed at establishing with Member States an integrated and shared EU-wide environmental information system.

This Clearing House Mechanism relies to a certain extend on geographical information provided by the Global Monitoring for Environment and Security (GMES) initiative. Methods, models, data sets and prediction tools, which can be enabled by information and communication technologies, would assist in understanding and forecasting climate impact, in identifying vulnerability and in developing appropriate adaptation measures. Further work is necessary to evolve these tools. This is also reflected in the proposal of the EC 2011 in establishing the Horizon2020 program[1] , where within the frame of the societal challenges of Horizon 2020 under 'Inclusive, innovative and secure Societies' the "strengthening of the monitoring of infrastructures and the development of global multi-hazard early warning and risk management information systems" through the "use of satellite-based earth observation frameworks" has been highlighted.

Consideration of cost/benefit analysis that should be carried out to appraise the viability of alternative disaster risk mitigation and climate change adaptation measures is increasingly required by European directives (e.g. the Flood Directive). However, this must be grounded on a better understanding of the type of damages that may occur and the underlying vulnerability mechanisms.
The MOVE and ENSURE projects provide relevant input for operational support for both aspects, how to improve vulnerability assessment tools and how to embed vulnerability facets into cost-benefit analyses.

1- See http://ec.europa.eu/research/horizon2020/pdf/proposals/com%282011%29_809_final.pdf

2.
Key achievements and challenges

Achievements

Definition and Concept

- *The two projects share the idea that vulnerability is the result of social, economic and political processes that shape the relationship between "natural" threats and exposed assets and communities.*

- *Both projects designed conceptual frameworks that integrate the perspectives of various schools of thought. One novelty of these frameworks is their development within a truly interdisciplinary team, composed of social scientists, geographers, geologists and engineers.*

- *The projects' partners are aware of the dynamic connection between the various thematic components, spatial scales and temporal phases of events, their impact and the response of the vulnerable objects and populations.*

- *The projects also provide a contribution to an integration of vulnerability into Natural Hazard risk assessments in Europe.*

Application and Practice

- *The work in both projects confirmed the necessity of cooperation with stakeholders and "end users". The integration of such key persons is essential for generating usable and useful "end-products". In addition, this is the*

only way to guarantee that relevant aspects for decision making as well as constraints due to administrative procedures are considered.

- *A common finding is the importance of providing indicators, parameters and tools of appraisal that use a graspable language or provide an explanation of terms so that their potential is fully appreciated and understood by practitioners and decision makers.*

- *Both projects underline the crucial role that qualitative information may play in order to not miss out on relevant aspects shaping risk when rigorous quantitative modelling is not achievable.*

- *The MOVE project placed a strong emphasis on the provision of a toolbox comprising essential methods and instruments to be applied for vulnerability assessments, thus facing the challenge of satisfying different user needs according to evaluation goals, policy needs, and data requirement/availability.*

- *The ENSURE project developed a set of matrices addressing resilience, physical and systemic vulnerability assessments for a number of hazards. In doing so the project structured the pre-existing body of knowledge relating to vulnerability and resilience parameters, using available past research, literature and applied experience.*

Challenges

- *Vulnerability and resilience have strong temporal and spatial dynamic facets that need to be taken into account more intensively when assessing them*

- *The representation of the dynamics of vulnerability (incl. temporal and spatial scale) within assessment/ analysis frameworks is still not convincing.*

- *Climate Change Adaptation and Disaster Risk Reduction are intimately linked, but still lack a common terminology as well as consensus-based approaches.*

- *The validation of vulnerability and resilience assessments requires a consolidated concept and practical guidelines. From a user's perspective, the provision of validated information will certainly improve the acceptance of assessment results.*

- *Climate Change Adaptation and Disaster Risk Reduction can only effectively be implemented when integrated in the context of national development agendas (e.g. coping capacity, resilience). This nexus needs further attention.*

- *On the way to action, the science-policy dialogue lacks coordination and therefore impact.*

2.1. The Vulnerability Concept

Both projects had identified the development of a conceptual framework as a first major goal. The elaborated frameworks encompass the various aspects and facets of vulnerability that were recognized in the literature and in previous work carried out by partners. These frameworks also attempted to integrate the various "schools of thought" ranging from earthquake engineering to systems engineering, climate change and ecology. The development of such frameworks challenged the research teams to establish full cooperation

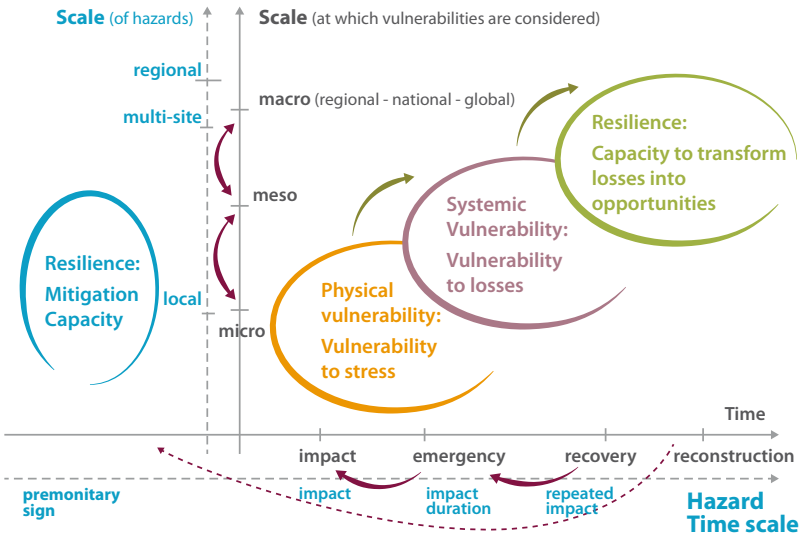


Figure 1. Conceptual framework of the ENSURE project

and reach common ground compromise. As results stand, two different but path-breaking integrative frameworks have been achieved, as well as a widening of horizons for the scientists who embraced the role of accomplishing these interdisciplinary outputs.

An initial assumption of the ENSURE project was that a bridge between "social" and "natural" scientists (Ginzburg, 1980) should be constructed in order to improve the usability of tools provided for decision makers. The point was not just making the two scientific fields communicate, but of actually developing good science at the border of the two approaches (and the many more disciplines within each approach) in order to address issues that cover both, that is the material, physical, human and social aspects that contribute to the overall vulnerability of a place and community. The conceptualization required the extension of the initial focus on vulnerability to a related crucial concept, namely that of resilience. It has been recognised that resilience and vulnerability are neither overlapping nor totally independent concepts. Finally, within the framework both concepts were accommodated across two axes

representing the temporal (x) and the spatial (y) scales. Resilience as a mitigation capacity in the pre-impact phase is addressed, whilst physical vulnerability is assessed at the impact phase. Systemic vulnerability, intended as "second order" vulnerability, describing a failure to cope with initial physical damage, is considered central in the emergency, post-impact phase. Resilience gains prominence in the recovery and reconstruction efforts: as in the case of systemic vulnerability, the response is not to the stress, but to the longer term induced, indirect, secondary effects it has triggered. What is measured here is not merely a response capacity, but rather whether or not systems are able to recover by reducing pre-event vulnerabilities, to learn from the weaknesses that the event has revealed and to transform reconstruction into an opportunity to build and develop a better, safer and healthier place to live (Handmer and Dovers 1996; Norris et al. 2008).

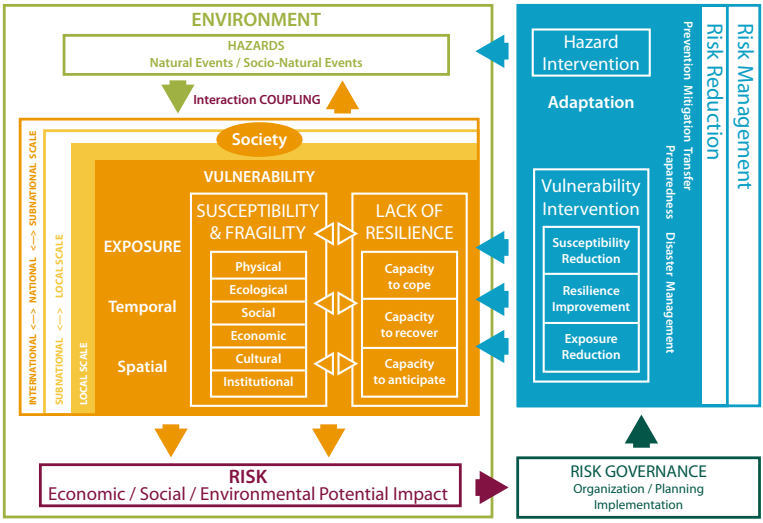


Figure 2. Conceptual framework of the MOVE project

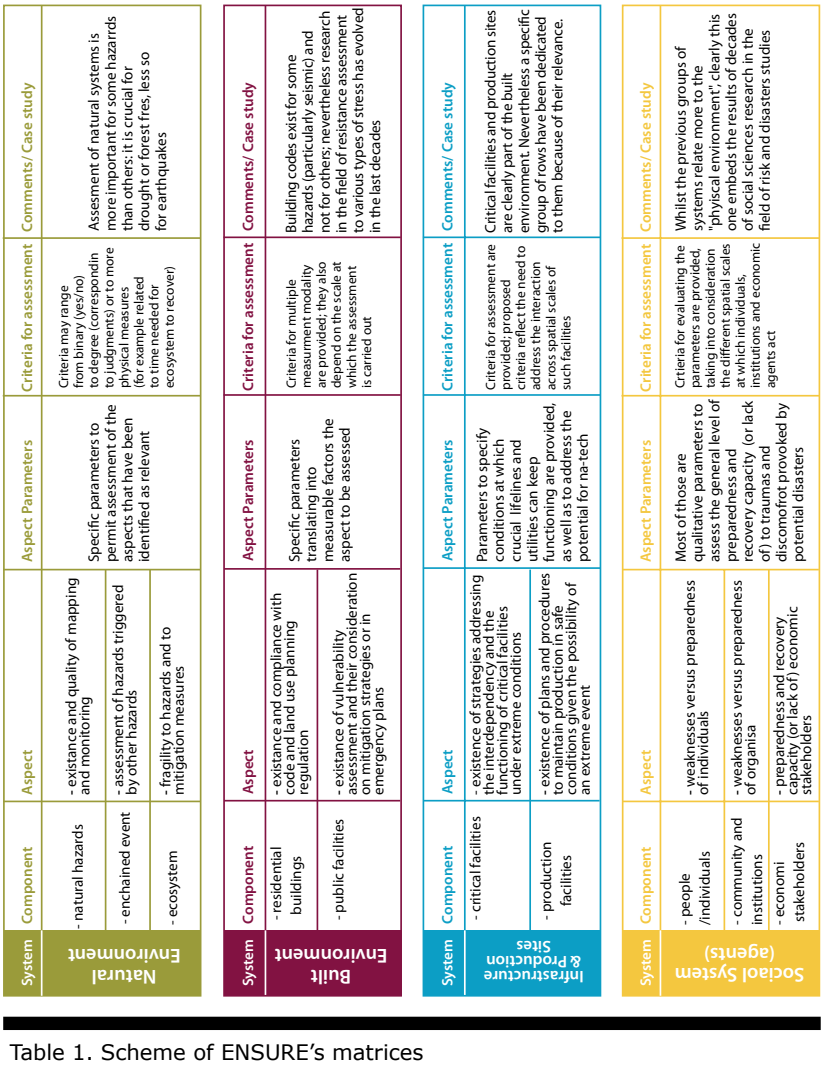
The MOVE framework has been developed as the base for a multi-dimensional, holistic vulnerability assessment, understood as part of risk evaluation and risk management

in the context of Disaster Risk Management and Climate Change Adaptation. This conceptual framework represents a pre-analytic vision that shows the linkages between key concepts such as vulnerability, risk and adaptation. It attempts to combine approaches stemming from the research areas of political economy, social-ecology, holistic vulnerability and disaster risk assessments, as well as climate change. It provides an improved conceptualization of the multi-faceted nature of vulnerability, accounting for key causal factors such as exposure, susceptibility, lack of resilience (lack of societal response capacities) as well as of the different thematic dimensions of vulnerability: physical, social, ecological, economic, cultural, and institutional. The framework also aims to emphasize the fact that environment and society are not solely linked through a specific hazard or stressor. Rather, the framework underlines that society and nature/environment are coupled through various linkages. Additionally, the framework incorporates the concept of adaptation into disaster risk management, and therewith explicitly differentiates coping from adaptation. The framework has been validated from the scientific point of view as well as from stakeholders dealing with the application of vulnerability assessments.

Beyond this framework the MOVE project contributed to bridging the gap between theoretical concept and application in practice, with guidelines providing procedural steps for stakeholders to assess vulnerability to natural hazards by means of indictors and to integrate the respective assessment results into a risk management framework.

2.2. Towards the Application of Vulnerability Assessments

Based on the theoretical concepts and methods developed, both projects made the extra step into application. They provided tools and sets of indicators that permitted measurement and assessment of certain aspects of the complex issue of vulnerability, as well as tested methods and



System	Component	Aspect	Aspect Parameters	Criteria for assessment	Comments/ Case study
Natural Environment	- natural hazards	- existance and quality of mapping and monitoring	Specific parameters to permit assessment of the aspects that have been identified as relevant	Criteria may range from binary (yes/no) to degree (correspondin to judgments) or to more physical measures (for example related to time needed for ecosystem to recover)	Assesment of natural systems is more important for some hazarrds than others: it is crucial for drought or forest fres, less so for earthquakes
	- enchained event	- assessment of hazards triggered by other hazards			
	- ecosystem	- fragility to hazards and to mitigation measures			

System	Component	Aspect	Aspect Parameters	Criteria for assessment	Comments/ Case study
Built Environment	- residential buildings	- existance and compliance with code and land use planning regulation	Specific parameters translating into measurable factors the aspect to be assessed	Criteria for multiple measurment modality are provided; they also depend on the scale at which the assessment is carried out	Building codes exist for some hazards (particularly seismic) and not for others; nevertheless research in the field of resistance assesment to various types of stress has evolved in the last decades
	- public facilities	- existance of vulnerability assessment and their consideration on mitigation strategies or in emergency plans			

System	Component	Aspect	Aspect Parameters	Criteria for assessment	Comments/ Case study
Infrastructure & Production Sites	- critical facilities	- existence of strategies addressing the interdependency and the functioning of critical facilities under extreme conditions	Parameters to specify conditions at which crucial lifelines and utilities can keep functioning are provided, as well as to address the potential for na-tech	Criteria for assessment are provided; proposed criteria reflect the need to address the interaction across spatial scales of such facilities	Critical facilities and production sites are clearly part of the built environment. Nevertheless a specific group of rows have been dedicated to them because of their relevance.
	- production facilities	- existence of plans and procedures to maintain production in safe conditions given the possibility of an extreme event			

System	Component	Aspect	Aspect Parameters	Criteria for assessment	Comments/ Case study
Social System (agents)	- people /individuals	- weaknesses versus preparedness of individuals	Most of those are qualitative parameters to assess the general level of preparedness and recovery capacity (or lack of) to traumas and discomofrot provoked by potential disasters	Criteria for evaluating the parameters are provided, taking into consideration the different spatial scales at which individuals, institutions and economic agents act	Whilst the previous groups of systems relate more to the "physical environment", clearly this one embeds the results of decades of social sciences research in the field of risk and disasters studies
	- community and institutions	- weaknesses versus preparedness of organisa			
	- economi stakeholders	- preparedness and recovery capacity (or lack of) economic stakeholders			

Table 1. Scheme of ENSURE's matrices

techniques in selected test cases.
In order to make ENSURE's perspective operational, each component of the previously illustrated framework was translated into a matrix. In the first of the four resulting matrices, the capacity to mitigate by, for example, providing state of the art, good quality monitoring and community based warning systems, is appraised. In the second, physical vulnerability parameters are considered; in the

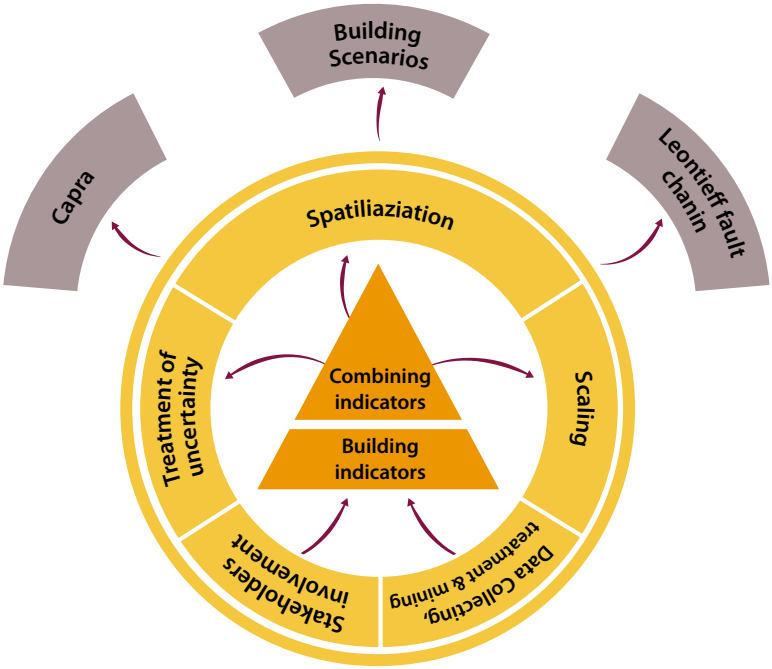


Figure 3. MOVE Vulnerability assessment tools: VA core tools (dark orange), complementary tools (light orange), optional tools (purple)

third, interdependency, redundancy and transferability factors (see Van der Veen and Logtmeijer, 2005) are evaluated; and in the last, instruments and resources for reconstruction are addressed.

The ENSURE project adopts a systemic perspective, in that it recognizes that vulnerability is nested in interdependencies, particularly in complex environments, both natural and built. Coherently, each matrix is subdivided into four macro-systems, natural, built, critical infrastructures, and socio-economic. The rows address specific aspects that need to be addressed for each subsystem.

The parameters that are used to "measure" the level of vulnerability and resilience (column 4) resulted from a systematizing effort of already available and newly developed vulnerability (and to a certain extent also resilience) indicators.

Foto 2. Vulcano Island

A set of four matrices (mitigation capacity; physical vulnerability and systemic vulnerability; resilience) was developed for different hazards (seismic, floods, drought, forest fires, volcanic and landslides). An extensive literature and case studies investigation was carried out to identify the best indicators provided in each domain and highlighting areas for future research.

The ENSURE methodology was applied to three test areas (see the Final Booklet in the Ensure website) and to a number of case studies (see as an example Menoni et al. 2012; Costa and Kropp, 2012). Results showed that the framework and associated matrices were of use to guide assessors in recognizing strengths and weaknesses in the areas of concern. Furthermore, the methodology also proved to be useful in supporting vulnerability assessment to multiple hazards: vulnerabilities to hazards that may be combined in cascading and domino events are already addressed in the individual matrices, whereas the use of different sets of matrices in the same area permitted to have a wide view of vulnerability to multiple independent threats.

Within the MOVE project a number of products were generated in order to bridge the existing gap between the theoretical conceptual approaches to encompass vulnerability on one hand, and the assessment of vulnerability in practice, on the other. A set of procedural steps has been developed to apply the MOVE conceptual framework within the wider context of risk governance; with

the final goal of identifying and developing best strategies for risk reduction. These procedural steps cover the activities of hazard, vulnerability and risk assessment, as well as of risk management. Available methods and tools to implement them are described within the MOVE Manual, where crucial topics such as stakeholder involvement, data mining and treatment of uncertainty, as well as scaling and spatialisation methods, are critically reviewed[2].

A particular focus was set on the development and aggregation of indicators[3]. The use of indicators and composite indicators to assess vulnerability is increasingly recognized as a beneficial tool for measuring, surveying and monitoring vulnerability. Beyond its scientific application indicators and indices represent an important tool as a basis for policy making and public communication. In addition to a list of quality criteria supporting the selection of indicators, a MOVE data base of key indicators has been established.

The application of the MOVE concept and methodologies have been tested in seven case studies covering some of the most relevant hazard types, physical landscapes and cultural environments in Europe. The results, including an external validation, have been summarised in a MOVE 'lessons learnt' paper (Papathoma-Köhle, 2011).

2- The MOVE Manual can be downloaded from http://www.move-fp7.eu/documents/MOVE_Manual.pdf

3- The MOVE indicator database visualiser can be found here: http://www.gi4drr.org/move/move_query/

Further information can be found on the projects' Websites:

- For the ENSURE project see: http://www.ensureproject.eu/; and also the e_learning platform that can be reached through the project web page or at: http://ensure.metid.polimi.it/web/. Free registration is required for the latter platform.
- For the MOVE project see: http://www.move-fp7.eu/. The MOVE website includes a manual for users containing an overview of available methods (MOVE manual: http://www.move-fp7.eu/documents/MOVE_Manual.pdf), a handbook which summarises the case studies (MOVE handbook, to be published later; http://www.move-fp7.eu/documents/MOVE_Handbook.pdf) and an online indicator database (http://www.gi4drr.org/move/move_query/).

3.
Vision and Recommendations

Vision

"the situation we would like to see in the future"

• Research strategies take into account the multi- and transdisciplinary approach of risk assessments (holistic approach) to facilitate the dialogue and collaboration between diverse research communities.

• In assessing vulnerability and resilience to both "natural" hazards and climate change, economic, social and political drivers are fully considered; implementation and research aim to integrate climate change and natural hazard related issues under a common umbrella.

• Dialogue between users, policy-makers and researchers strengthens the uptake of results, facilitated at a policy level through dialogue between the different EC institutions involved , and between EC and national stakeholders.

• Quality of applied research is measured with appropriate indicators.

Recommendations

• Integrative and systemic approach: A strong emphasis on transversal aspects should be pursued and strengthened in the development of calls.

• Continue to foster the development of methodologies and

tools to deal with the dynamic nature of vulnerability (e.g. cascading effects and time-dependent vulnerability).

- *Call for the validation of vulnerability and resilience concepts in the context of disaster risk reduction.*
- *Enhance the multi-risk approach.*
- *Improve the communication and interaction with stakeholders.*

In the following we would like to draw some conclusions concerning tackling risk and vulnerability assessments that both address the most relevant policies and programmes referred to in paragraph 2., and summarize the most important project outcomes from MOVE and ENSURE. These remarks concern existing problems and disparities. They outline a joint vision and more specific recommendations which should assist the development of future research strategies and programs. The vision therefore reflects an ideal state of risk research in the future. The recommendations target specific research needs in the context of risk and vulnerability.

3.1.
Vision - Some thoughts about research at European level, namely EC's funding of science activities within the context of HORIZON 2020

Research strategies and research programs – particularly at a high level such as the European one - should embrace and balance out appropriately both the consolidation of baseline research and the support of policy relevant research. This is the case for the 'Europe 2020' strategy and for research in Horizon 2020; in this context we would like to raise a number of specific issues:

Transversal aspects

Apparently the only current transversal issue in 'Horizon 2020' is ICT. Transversal issues, related to economy and society, are not considered equally. For example, the way spatial planning is pursued and buildings and infrastructure (including critical, assets, urban fabric etc.) constructed, used and transformed is also driven by cultural, social and economic forces and constraints. Not identifying the "physical" and "systemic" facets of vulnerability (or resilience) resulting from such social, cultural, economic and political actions, may result in the failure of risk prevention initiatives.
An additional issue is that proposals and projects need to demonstrate that they are aware of research that has already been carried out under previous calls and that they are advancing beyond these previous achievements. In the future we think an exchange of ideas and results should be reinforced, providing incentives for projects to share results and encouraging them to participate in each others' workshops and seminars. The present paper is an example of a joint activity between two projects funded under the same call: such collaboration proved to be challenging but fruitful and could also occur among teams whose projects have similarities and potential commonalities beyond the fact they have been funded under the same topic.

Integrating CC and risk

The overarching attention to climate change is justified, with an obvious preoccupation relating to the quality of the global environment and the search for more sustainable forms of human activity. However, this approach forces markets and industries towards an environmentally sustainable economy, based on 'green' innovation. This is certainly fundamental, as the European 2020 Strategy recalls that better preparedness regarding future climate driven disasters should be pursued. Nevertheless, history, including European history, has shown that natural extremes, as well as anthropogenic hazards (such as industrial accidents) can be expected at any time (in addition to climate change),

and may significantly challenge the areas they affect as well as the wider periphery with which economic, cultural and economic relationships exist. In the same vein, Horizon 2020 (as part of the European 2020 strategy) seems to address climate change as an isolated issue, in a way that may endanger the last years' achievements in terms of integration efforts related to harmonize terms, issues, and topics. Vulnerability and resilience are at the core of the common scheme regarding how an "external" stress will influence the life of a given community.
Our vision therefore is that future (research) strategies should aim at integrating climate change and natural hazard related issues. Assessing vulnerability and resilience is one of the common concerns of both disaster risk and climate change scholars. Both hold that the economic, social and political drivers of vulnerability and resilient response and mitigation capacity cannot be neglected.

Encourage transfer from science to application and policy support

There is increasing pressure to justify the expenditure of public financial resources for research and scientific projects. This has led on the one hand to extended and improved dissemination actions of project results, and on the other hand to a stronger consideration of how society benefits from research activities and how project results will be used by so-called 'stakeholders'. In this context research in general has been pushed to work more on output and application, but there is still a need to improve the transfer from theory to practice. Increased financial support (from DG Research) for projects that include the integration of stakeholders in the form of public authorities as practiced within Territorial Cooperation projects or SMEs in other programs, is a step in the right direction. However, often the long-term goals of research institutions, public bodies and the private economy vary to such a degree that the achievement of best possible project results is hindered. Here we see the necessity of bringing these different actors closer together by structuring funding programs accordingly

and by offering incentives for successful cooperation.

3.2.
Recommendations – some concrete proposals to better account for vulnerability and resilience in research as well as in risk and climate related policies

Integrative and systemic approach

An overarching topic is that risk and vulnerability assessment and related research must, as a starting point, follow a systemic and integrative approach. It is clear that in order to construct an overall picture of the level of vulnerability and/or risk to natural hazards a society is facing requires looking beyond the borderlines of single disciplines or single sectors. Risk and vulnerability assessment activities taking an integrative and systemic approach are thus challenging traditional sectoral and linear structures and decision-making procedures. Interdisciplinary research is not an easy task and a number of barriers exist, including persisting academic opposition (Nicolson et al, 2002; Lélé et al., 2005). Policy and decision makers may decide to favour or to provide incentives for interdisciplinary work, for example allocating funds through research programs and calls specifically asking for interdisciplinary research or providing a highly ranked open source journal that favours and encourages cross- and inter-disciplinary contributions.

One important point that has arisen from the MOVE and ENSURE projects is the need for stronger integration of the different aspects that compose risk, both in the analytical phase and in the design of prevention measures (and their implementation). In this regard, a stronger emphasis on the transversal aspects of issues such as transport, social security and well-being, as

well as adaptation to climate change should be pursued and strengthened in the development of calls and specific applications. Additionally, as pointed out in the MOVE and the ENSURE frameworks, cultural and institutional dimensions play a critical role and their integration in the holistic vulnerability context is needed. In fact, the two projects emphasise the need to create and reinforce the bridge between the "natural" and "social" sciences in dealing with risks.

The request for system-orientation as it has been demanded by both projects is not new and follows the formulation of the sustainability research community decades ago. But changes in this respect take time and therefore it is not surprising that only some progress has been made in the past years. Researchers, practitioners, donors and stakeholders should be continually reminded as well as encouraged into thinking and acting in an integrative way. From experience gained in the MOVE and ENSURE projects, efforts to foster horizontal (cross-sectoral) as well as vertical (cross-level) initiatives for risk governance and the calls for respective research are highly appreciated.

Another important point to mention here is the relevance of activities that have been carried out outside of Europe. Addressing issues relevant for risk and vulnerabilities has been the subject of numerous studies and projects in the context of sustainability research for a long time, particularly in developing countries, even if often under a different name. We would recommend looking more at the tools and methods developed in this field and in learning from activities undertaken.

Further develop and implement the dynamic nature of vulnerability

What has perhaps been less well achieved in these two projects and deserves further attention is the recognition that a more dynamic consideration of vulnerability needs to be adopted. In fact, in complex, linked events cascading effects may occur in which what is vulnerable to the initial

triggering hazard (an earthquake) becomes in turn a hazard in itself. A typical example is provided by hazardous installations that are potentially vulnerable to natural hazards that may be in their turn a trigger of a top-event accident (the so-called NATECH). Physical vulnerability and the consequent damage can trigger systemic and ripple (domino) effects across urban, regional, social and economic systems in ways that go far beyond what is traditionally taken into consideration.
Alongside short-term dynamics, the issue of long-term future changes also arises in the context of vulnerability. The development and applicability of future vulnerability scenarios should be further explored not only in regard to the various methodologies developed but also regarding their usefulness to decision-makers.

Validation of vulnerability concepts and methods

Both projects have developed new concepts and highly relevant methodologies - alongside other similar scientific work in recent years. The newly developed approaches have been validated during the projects' lifetime, through applications (Ensure/Move) and collaborative work with relevant stakeholders (Move). We recommend placing an emphasis not only on stimulating new developments but on the consolidation of existing knowledge and research achievements. In addition, we propose the conceptualisation of a common validation process with the aim of streamlining the large number of existing concepts, including the integration of different user groups. A joint endeavour to consolidate and harmonize existing results under a common validation process of methods and concepts would be an essential step forward in current research.

Implement and validate resilience and other upcoming concepts in the context of disaster risk reduction

Meanwhile it has been accepted that looking at vulnerability

(of populations and societies) is not sufficient in embracing all relevant aspects neither within the context of risk governance nor in order to decide on the best and most adequate adaptation/mitigation strategies. The results of current and future research activities need to be taken into account so that risk assessments/ risk governance methods can be continuously updated with state– of–the–art research. In addition, a certain effort should be made to detect timely and promising new research fields within the context of disaster risk reduction as well as designing respective research calls/schemes accordingly.

Foster the use of 'qualitative data'

The results of both projects have shown that the integration of 'qualitative' data is indispensable for understanding the complex issues of vulnerability. Information about historical developments, levels of hazard and risk awareness, existence of informal networks and the generally unknown mitigation strategies are often only reportable narratively. We believe that this type of qualitative information is crucial for deciding on future actions and strategies. We would like to stress the importance of developing further methods that allow for the integration of qualitative and quantitative data, as well as emphasising the need to raise awareness of the significance of doing so in the context of risk assessments.

Enhance multi-risk approaches

The two projects recognise the limitations of current methodologies in tackling vulnerability and resilience in areas that are exposed to a variety of threats. Recent policy documents, as well as recently funded projects, are tackling the issue of multi-risk and multi-hazard assessment. We are moving from the concept of individual, isolated disasters towards a more complex understanding of coupled events, with cascading and/or combined effects as well as multi-site occurrences, which significantly challenge the capacity of civil protection and other concerned agencies to respond adequately. The first application of the methodologies to

the case studies demonstrated that such vulnerability assessment in a multi-risk context is possible, though further research is needed in this area, including the fine-tuning of the methods developed by the MOVE and ENSURE projects.
The studies on vulnerability carried out by the two projects have highlighted the importance of both spatial and temporal relations. The fact that vulnerabilities are shaped across spatial and temporal scales has been recognised, yet the links are not easy to model. Further work is required in this respect (see Costa and Kropp, 2012).

Better communication and interaction with and improved integration of stakeholders

Risk and vulnerability studies only lead to improved risk governance if the relevant stakeholders are involved in the process of any assessment right from the beginning. A quantification of certain aspects of risk and vulnerability always includes components of normative character and are hence subjective. Evaluation, weighting, drawing borders and defining thresholds will only be accepted by practitioners and will only have an added value for planning of future activities when conducted jointly with stakeholders.

Make results more user-friendly

The MOVE project has put a strong emphasis on transferring scientific results into products that are digestible for non-scientific users, in order to enhance the positive impact of research when applied in practice. The MOVE toolbox investigation, for example, has shown that there are a large number of pre-existing tools and methods for undertaking various work and analitical steps for a vulnerability assessment. However, the majority of this 'scientific gear' has not yet been handed over to the potential end-user, mainly due to communication gaps between the research world and practitioners. We therefore strongly recommend

that more effort should be made to translate research results into practical products ready to be taken over by the user.

Work on data

The lack of data is a never ending story. We are aware that many scientists tend to justify problems in their approaches with the fact that data are not available and/or are insufficient in quality. Nevertheless, we appreciate the vast improvements made in recent years, particularly in Europe concerning standards for acquiring, classifying, describing and validating data. This progress also shows that positive changes are possible when a clear strategy and adequate resources are implemented. In our opinion there is still room for improvement with respect to data standardisation (in parallel to the efforts of the INSPIRE initiative) for data of importance for risk and vulnerability assessments, namely those dealing with cultural / institutional issues.
The same applies to data accessibility, which has also made great progress in recent years. However, the effort should continue. One example of this progress is the greater accessibility and lower cost of EO data as one important source for monitoring activities, even if only partly usable for a variety of crucial vulnerability issues.

Foto 4. Aquila

3.3. Conclusion

In this paper we formulate some key messages drawing from the results of two recently finished projects funded under the EC FP7 environment call on vulnerability and resilience. There are important commonalities in the achieved results and those are presented as basis for future work.

In particular, it is felt that such results can be already of use to support policies and programmes set at the European and also at the national level in many European countries. Such effort will certainly require to make existing tools even more operational and hence usable. In the meantime, more effort has to be devoted to embed vulnerability and resilience evaluations into risk assessment and scenario modelling. Furthermore, in a shared effort undertaken by researchers and decision-makers it has to be verified, in what way and to which extent such new and more comprehensive risk assessments can be integrated in organisational procedures and in policy-making processes. Bridging the gap between science and policy particular needs further attention, as well as considering requirements of certain stakeholder/policy groups when developing new approaches in the scientific domain.

Certainly, the scientific effort per se is not at an end: more has to be understood with respect to the way societies, economies and institutions respond to natural calamities as well as to the already visible effects of climate change. More has to be done to bridge between "natural" and "social" scientists, between disaster risk and climate change researchers. Truly interdisciplinary results is still an objective unobtained and that would benefit from an evolution in both academic and practitioner arenas.

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"MOVE" and "ENSURE" are two projects that have been funded within the European Commission's FP7. They both focused on vulnerability and explored ways of enhancing the capacity of assessing vulnerability, and suggesting ways of improving its inclusion in scenario modelling and risk analysis. Both have developed frameworks and methods that have been a) tested in case studies and b) presented to stakeholders in order to obtain their opinion about the practical viability and potential use of the framework and methods in policies and administrative processes.

This paper is a joint effort made at the end of the two projects' activities in order to share common results with the wider scientific and decision making communities. It intends to support relevant European policies and to contribute to the discussion of future research, particularly within the context of risk caused by hazards and environmental change.

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