SHORT EXECUTIVE SUMMARY

Knowing better and losing less

Natural and human-induced disasters present major risks to the economy, the security and well-being of citizens and society. Addressing these risks relies on robust evidence-based decision-making. A main challenge for policy-makers and practitioners addressing natural and human-induced disaster risk management, across all policies and sectors, is to capitalise on the wealth of existing knowledge at all levels – local, national, European and global.

Science and technology play a central role in many EU policies and international agreements addressing disaster risk management. Ensuring efficient disaster risk reduction and prevention measures relies on a robust understanding and assessment of risks.

The UN Sendai Framework for Disaster Risk Reduction calls for a strong interface between science and policy to build a strong knowledge of disaster risk; make efficient use of data to better understand the economic impacts of disasters; and develop adequate preventive policies to reduce the risks of disasters. Science and innovation equally contribute to several Sustainable Development Goals and their associated targets. In the context of the Paris Agreement on climate change, the importance of data collection, evidence-based approaches and the contribution of science was recognised.

This report presents a synthesis of scientific knowledge in the field of disaster risk reduction. It draws from many scientific disciplines, practitioner communities and policy experts. It is organised in 6 parts. Chapter 1 summarises the policy landscape. Chapters 2 and 3 present the available knowledge on risk assessment respectively from a multi-hazard and hazard specific perspective. Chapter 5 discusses science for managing disaster risk, and Chapter 4 bridges science and practice by focusing on communication of risk. Finally, Chapter 6 summarises challenges brought forward by all authors.

Current status of disaster risk management and policy frameworks

A main challenge for policymakers addressing natural and human-induced disaster risk management, across all EU policies, is to capitalise on the wealth of existing knowledge at all levels — local, national, European and global. In order to improve all stages of the disaster risk management cycle — prevention and mitigation, preparedness, response and recovery —, the knowledge and evidence base needs to be further improved, advances in relevant technology exploited, research results applied and the interaction between researchers and end users enhanced. Understanding the state of play of policy frameworks relevant to disaster risk management will help strengthen the interface between science and policy required to reduce the risk of disasters and enhance our prevention and mitigation, preparedness, response and recovery.

Understanding disaster risk: risk assessment methodologies and examples

Risk is complex. There have been huge advances in recent years in all of the key areas of risk: hazard, exposure and vulnerability. The science base in Europe is a rich source of information and data. Initially there was often a culture clash between the needs of industry for practical useable information within tight timetables, perhaps just representing what is known, compared to academia's focus on research and discovery with necessarily longer time horizons. With greater exposure and encouragement, including EU research grants promoting partnerships between the public and private sectors and academia, scientists and practitioners are now more attuned to working closely with each other. Similarly, methodologies have now been developed to categorise risk, model risk and present the results of risk assessments and analysis in forms that enable decision makers not only to decide the right course of action but also to provide transparency around the decision-making process.

The process of risk understanding is not simple and data are always partial and flawed. Initial models and analysis may be viewed as simplistic, particularly in retrospect. The discrepancies in data quality are sometimes asserted an excuse to delay risk analysis and modelling, but it is infinitely better to embark on a risk assessment and analysis process from the outset than wait until better data become available. A "1 in 100 event" could happen tomorrow, it is better to have tried, and commit resources to develop a greater understanding of the risks as far as possible now (and so identify key weaknesses and data gaps) than postpone action until better data are collected.

Risk assessments and risk models cannot make decisions but they can inform policy. Policymakers may reject the advice of a risk model but if they do so, they should be able to articulate why. In practice no model includes all factors; decisions based upon broader considerations are often valid. But there is no

doubt that encouraging and developing a culture of risk identification, risk understanding, risk assessment and risk modelling ultimately benefits society, making it more resilient and saving lives, livelihoods and property.

Understanding disaster risk: hazard related risk issues

Today monitoring of geophysical phenomena is performed with well-developed instrumental recording networks extended at global, regional, national and local levels. However, since large geophysical events tend to occur infrequently and may appear benign for generations, the risks may be underestimated. The assessment of risks posed by earthquakes, volcanic eruptions and tsunamis first requires a good knowledge of the type, magnitude and frequency of past events. The preparation of hazard maps is a good practice not only for decision makers but also for citizens who would like to know where the hazardous areas are situated and what types of hazards threaten their community.

There is important room for further improvement of monitoring systems and their geographic expansion in less well covered areas. If appropriate monitoring is in place, it may be possible to issue early warnings for different hazards and to provide short term forecasts of likely future activity. The assessment of event scenarios can play a critical role in the development of risk management and risk reduction measures, such as elaboration of emergency plans, development of infrastructure to support the affected regions, or risk awareness campaigns.

Developing adequate hydrological risk maps is key for the short term (emergency response) as well as the long term planning (urban and rural development) to increase society's resilience to those risks. Fully comprehensive hydrological risk maps require a great deal of data including long time series of events, and/or a chain of models and assessments that reflect our level of understanding of the complex physical processes controlling hydrological events.

Different types of floods are predictable with different time ranges. Flash floods driven by convective rainfall are notoriously challenging to predict ahead in time to produce effective early warnings, whereas slower developing floods in large catchments can be predicted several days ahead with the use of probabilistic flood forecasting systems. Landslides mapping is a challenge due to the extraordinary breadth of the spectrum of landslide phenomena. No single method exists to identify and map landslides and to ascertain landslide susceptibility and hazard.

The majority of recent scientific studies indicate that hydrological risks will increase overall even for warming levels of 1.5°C. It is estimated that about 70% of the global coastlines are projected to experience a sea-level change within 20% of the global mean sea-level change.

Meteorological risks include hazards from different types of storm systems as well as extremes of temperature, climatological risks include droughts and wildfires and biological risks include epidemics and pandemics. In order to mitigate the effects of these hazards, an understanding of their origin, behaviour and evolution is critical. Building knowledge about human vulnerability to the various hazards is required, and region-specific hazard, exposure and vulnerability need to be analysed for different sectors.

Forecasting the onset or likely evolution of hazards is becoming more accurate through the use of new technologies; however there remains a degree of uncertainty which can be problematic for decision-makers as it can be difficult to strike the right balance between the risk of missing the opportunity for early warning and the risk of raising too many false alarms. Improvements in forecasting will be driven by the interaction and partnerships forged between different fields.

Disaster risk reduction frameworks have not commonly addressed technological risks. The Sendai Framework for Action recognises the importance of technological hazards and promotes an all-hazards approach to disaster risk reduction. This includes hazardous situations arising from man-made activities due to human error, mechanical failure, and natural hazards.

Chemical accidents continue to occur relatively frequently in industrialized and developing countries alike, which raises questions as to the adequacy of current risk-reduction efforts. The causes underlying chemical accidents in current times are largely assumed to be systemic. Most chemical accidents today are caused by violations of well-known principles for chemicals risk management which has led to insufficient control measures. Natech accidents are a technological "secondary effect" of natural hazards and have caused many major and long-term social, environmental and economic impacts. Studies on the status of Natech risk management in the EU and

the OECD have highlighted deficiencies in existing safety legislation and the need to consider this risk more explicitly. Conventional technological risk-assessment methodologies need to be expanded to be applicable to Natech risk assessment and only a very few methodologies and tools are available for this purpose.

Communicating disaster risk

Disaster risk communication is a growing field in disaster science, and highly relevant for policy makers, practitioners and citizens. It aims to prevent and mitigate harm, prepare populations of vulnerable areas before a disaster strikes; and to validate, share, disseminate and combine information from various sources both at times of disasters and in the recovery phase.

There is not a one size fits all in risk communication, as the local context (e.g. local cultures) and histories (e.g. previous experiences with disasters) matter. Risk communication based on a one-way approach that tells people how to prepare and to respond to a disaster is rarely effective. Instead, a two-way mode of communication will lead to a situation in which people become more engaged in risk communication. This engagement increases the likelihood that someone can successfully cope with a situation of uncertainty.

The key challenges in risk communication lie not so much in developing new tools and innovations but in the implementation of social mechanisms by which such innovations become embedded in actual communication practices. Adequate disaster risk communication and management requires the collaboration of a variety of stakeholders including policy makers, practitioners and citizens.

Managing disaster risk

The disaster management cycle commonly includes four types of measures needed to manage disasters: prevention/mitigation and preparedness (before a disaster), and response and recovery (after disaster). Holistic understanding of disaster risk management focuses on all four phases of the disaster cycle.

Based on an analysis of the benefits arising from avoided losses, mitigation and prevention measures are widely considered more cost-effective than ex-post disaster interventions. An increase in mitigation investment has occurred in some European countries, but the lack of public and therefore political interest in prevention and mitigation remains a problem.

In disaster preparedness and response planning there is a trend towards greater professionalization of emergency management across all Europe supported by evolution of legislative and regulatory frameworks. A comprehensive strategy for disaster financing can moderate the impacts of natural hazard risks, speed up recovery and reconstruction, and harness knowledge and incentives for risk reduction. The private financial sector plays an important role, along with governments and civil society organizations, in designing innovative financial protection goals and sharing knowledge and capacity.

Public-private partnerships are a model for a joint bearing of responsibilities and efficient risk-sharing, capable of increasing insurance coverage and penetration, and guaranteeing a strong financial backing in view of uncertain probabilities of risk.

Future challenges of disaster risk management

Drawing from the analysis in each chapter, the report concludes with a summary of challenges for knowledge, partnerships and innovation addressed to the three reader communities: scientists, policymakers and practitioners.