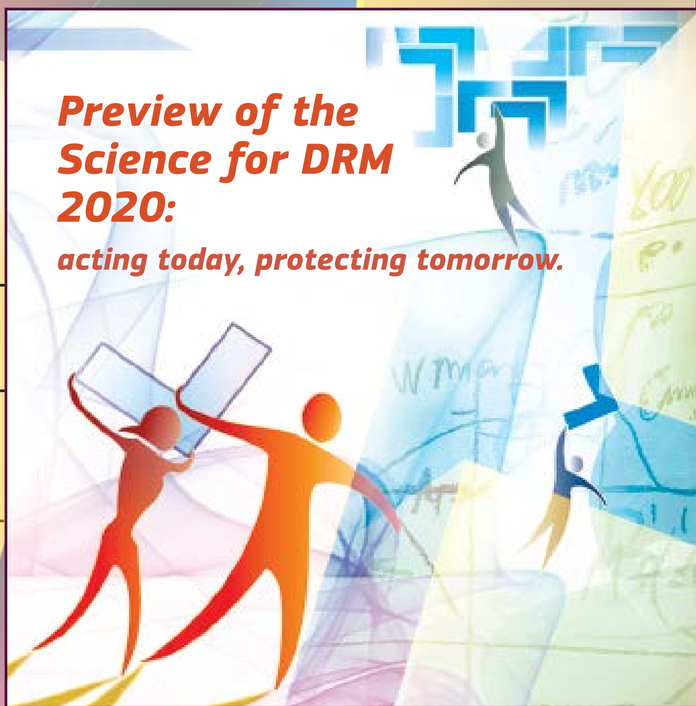
European Commission

Disaster
Risk
Management
Knowledge
Centre

SCIENCE for DRM 2020



Preview of the Science for DRM 2020:

acting today, protecting tomorrow.

Contact information
Name: CASAJUS VALLES Ainara (JRC-ISPRA)
Address: Via E. Fermi, 21027 Ispra (Italy)
Email: Ainara.CASAJUS-VALLES@ec.europa.eu

EU Science Hub
https://ec.europa.eu/jrc

JRC122177

PDF ISBN 978-92-76-23133-2 doi:10.2760/003011

Luxembourg: Publications Office of the European Union, 2020

How to cite this report: Casajus Valles A., Marin Ferrer, M., (eds.). *Preview of the Science for DRM 2020: acting today, protecting tomorrow.*, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-23133-2, doi:10.2760/003011, JRC122177.

After two intense years of collaboration with more than 300 experts in disaster risk management, we celebrate the International DRR day releasing a brief summary of the work done by the teams of authors for the Report Science for DRM 2020 : acting today protecting tomorrow. The Report aims to broaden the knowledge of disaster risk in Europe, by collecting and merging the scientific results and experience of several actors.

The Report is divided in six chapters and six super case studies, drafted by 25 teams of authors, with the support of an Advisory Group. All the contributions have been revised internally and externally, by a group of independent reviewers.

The Science for DRM 2020 focuses on analysing the consequences of a disaster on various assets (population, economic sector, critical infrastructures, environment and cultural heritage) to take advantage of the data and lessons that can be extracted in the aftermath of an event to propose paths of action to reinforce prevention, mitigation and adaptation.

Before its full publication, the current preview shares some of the ideas that will be contained in the full Report that will be public in December 2020.

Contents

CHAPTER 1

1 Introduction

The COVID-19 emergency that we are living through shows us what "systemic risk" means in practice, calling for stakeholders to collaborate, working across disciplines, sectors and levels. Science plays an important role in societal debates and supports policy-making. It helps increasing the awareness on the complexity of the problems at hand, facilitating the definition of the issues and formulating alternatives.

Since we cannot avoid some hazards to materialise, the main opportunity for reducing risk lies in tackling vulnerability and exposure. To do so, it is necessary to identify and tackle the underlying drivers of risk. The scientific community has put their efforts to enlarge the understanding and modelling risk; the number of national, regional and city risk assessments and sectorial risk assessments has increased recently, proposing evidence for planning measures to manage risk. A huge progress has been made in developing new technologies to capture signals and monitoring threats. In general, the research community has embarked in new projects to cooperate with end-users and other societal actors in programmes such as Horizon 2020 and the new Horizon Europe.

> "A good analysis of impacts is an essential source of knowledge to exploit to reduce disaster risk, both in the aftermath of an event but also to better predict future events."

In 2001, a Council Decision established a framework to reinforce prevention, preparedness and response to disaster risk with the creation of the European Civil Protection Mechanism (EU CPM). Risk anticipation and management are as well fundamental to major international agreements and frameworks in place since 2015: the Sendai Framework, Agenda 2030, the Paris Climate Agreement and the 2016 Urban Agenda.

In the current pandemic, the European Council agreed to an ambitious COVID-19 recovery plan, also known as 'Next Generation EU' that will contribute to the implementation of the new European Green Deal. These key policies mutually reinforce and are based on sound science and risk management principles.

The Report Science for DRM 2020: acting today, protecting tomorrow aims at putting evidence at the service of society through a collaborative effort of more than 300 experts. Disaster risk is studied through the analysis of the consequences of an event on various assets of interest, which will facilitate proposing action to tackle exposure and vulnerability factors and finally enhance resilience.

2 Integrating the risk management cycle

Disasters continue to undermine sustainable development so reducing its impacts and identifying pathways towards resilient societies is a global goal. As proposed by the Sendai Framework for Disaster Risk Reduction and the EU CPM, among other initiatives, understanding and assessing the drivers and patterns of risk is necessary to identify, plan and implement any measure to reduce risk.

Risk assessments serve to create a common understanding of the potential losses and damages. The information produced is used later to develop and put into operation the procedures, protocols and capabilities needed.

Risk concept, which definition is social and cultural dependent, has an uncertain and dynamic nature, making its study and management challenging. The need for evidence for informing policies and its implementation has gained importance in the last years.

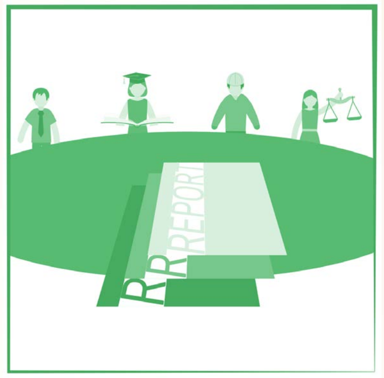
> "Risk, which is a social and cultural concept, has an uncertain and dynamic nature, making its study and management challenging."

The integration of natural and social sciences expertise is therefore needed to tackle risk. In Europe, science is one of the players but effective risk management requires other stakeholders to participate and share responsibilities in the decisions made.

This fact requires, the preparation of strategies of coordination and integration, ensuring that capacities exist and that knowledge flows among actors and institutions, supported by training and learning. Monitoring and evaluation mechanisms have proven to be a source of improvement of policies and measures.

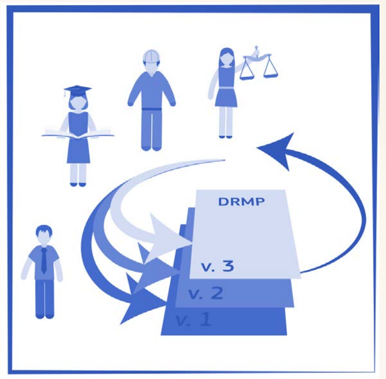
Communication is key to engage citizens, the most numerous and varied group, in all the activities mentioned.

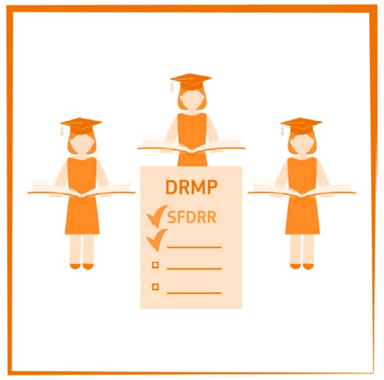
CHAPTER 2



• Disaster risk management and adaptation policies, strategies and plans should be based on a common understanding,

• Science is vital for efficiently implementing strategies for mitigating the most serious consequences.

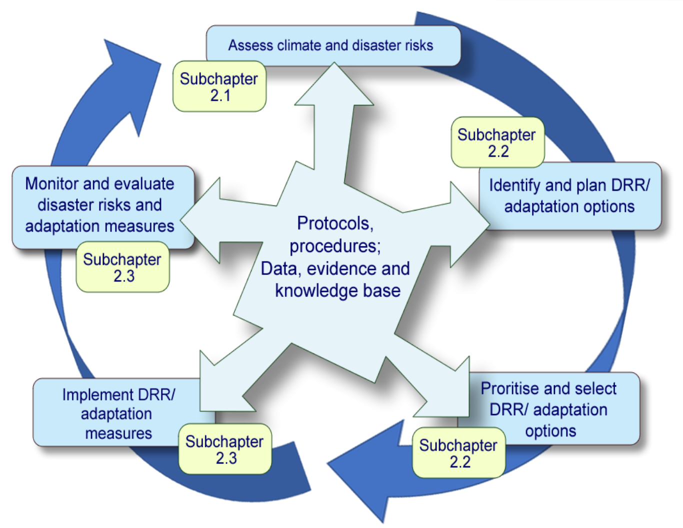




• Effective risk management requires multi-stakeholder, multi-level processes that are built upon continuous cycles of assessment,

A SHORT SAMPLE...

What can you find about those arguments Inside **Chapter 2** of the next ***"Science for Disaster Risk Management "*** 2020 edition book?



3.1 Methodologie for impact assessment

The negative consequences of disasters on population, including human activities and properties, are measured in causalities, injuries or economic losses. Traditionally, this type of data has been used during relief, to ensure that lives were not lost and to avoid injuries, and in the recovery, facilitating the daily life of communities to come back to normality. Nonetheless, certain impacts related to disasters, such as loss of cultural heritage or loss of biodiversity, are less obvious and not easy to measure in monetary terms.

Physical harm and destruction manifest immediately after the hazardous event, although some may become apparent in the long term, in time and space. Likewise, some effects happen as a consequence of the first impacts or as a result of the immediate actions taken. Indirect impacts can be a broad category encompassing disruption of societal life, businesses and services.

> "Collecting and sharing data after a disaster provide valuable information to expand understanding of risk, reinforcing prevention."

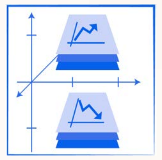
An overall assessment of the impacts allows understanding the magnitude and extend of a disaster in a territorial context. The study should address multiple spatial and temporal scales and consider a whole range of sectors that may have been affected. As said, analysing the needs after an event helps the emergency relief operations and the planning of recovery activities. It is necessary to know which have been the impacts to compensate the organizations and individuals affected and in a broader scope, governments and other stakeholders can use the information to reinforce emergency and recovery funds and protocols.

Finally, the data of damages and losses should be exploited as a source of learning to discover and interpret the drivers and conditions that facilitated these to happen. For example, investigations after earthquakes, volcanic eruptions and floods helped to develop fragility and damage curves, correlating construction characteristics to potential degree of damages.

These improves our capacity to anticipate future events and its consequences, which are vital for planning prevention, mitigation and preparedness measures. Despite the advantages stated, the collection and sharing of data is not a priority.

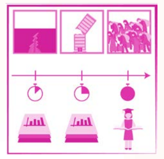
CHAPTER 3

Damage is usually related to the physical harm and destruction due to a disaster but it can also be triggered by a chain of cascading effects in time and space, including the effects of the decisions taken to mitigate the effects and facilitate recovery.

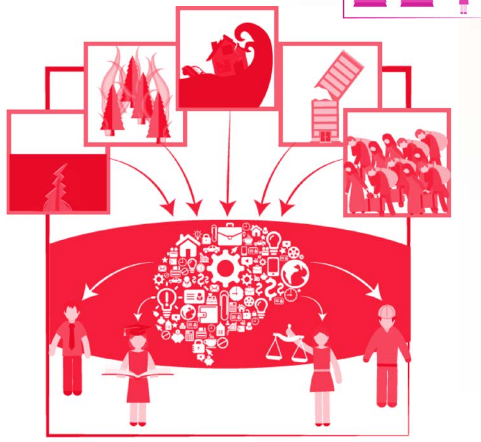


It is necessary to identify "gainers" and "losers" in different spatial scales in the long-term to assess the real effect of the impacts in the long-term.

Damage data collected after an event is initially required to respond to the most direct impacts and to deal with the recovery of it.



Data about damages and losses serve to study the drivers and conditions that lead to disasters, to design models to estimate risk in the future and to learn about the actions taken before the hazard materialized

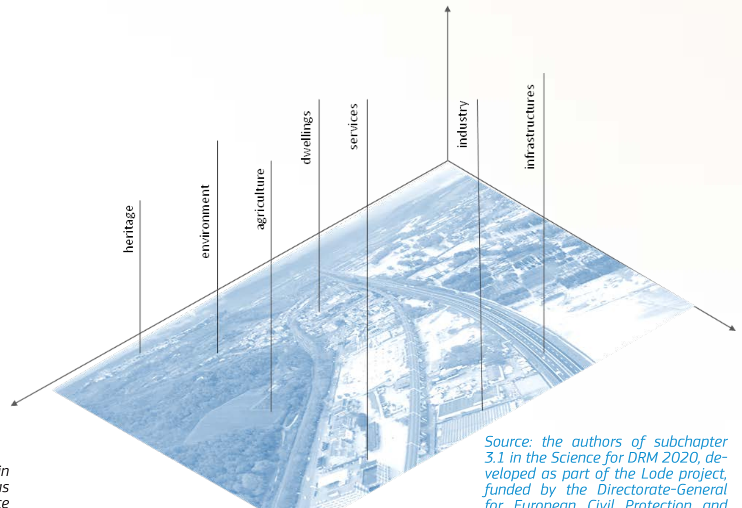


To analyse the consequences of a disaster in the after-math of the event, it is necessary to have already in place a system to collect and share data of the event and its impact among different stakeholders, ensuring timely availability and the consistency, accuracy and interoperability among sources.

A SHORT SAMPLE...

What can you find about those arguments Inside **Chapter 3** of the next ***"Science for Disaster Risk Management "*** 2020 edition book?

" The understanding of disaster impacts has significantly advanced in recent years. For too long they were limited to a few sectors such as residential buildings or agriculture; more recently, research and practice have targeted damage to economic activities, lifelines and services, and cultural heritage in a much more comprehensive way. "



Source: the authors of subchapter 3.1 in the Science for DRM 2020, developed as part of the Lode project, funded by the Directorate-General for European Civil Protection and Humanitarian Aid Operations (ECHO).

3.2 Population

“The socio-economic and environmental situation of a society before the disaster determines the potential consequences of the event, and these can be exacerbated depending on the quality of response and recovery actions taken after the disaster.”

Disasters affect and disrupt lives and livelihoods in different ways and with different intensities. Their consequences often affect people beyond those directly exposed, such as their families or social circles. Impacts can even be felt among communities at regional or country level when the magnitude and time of materialization of a hazard is extreme or when societies are not well prepared for such events.

At individual level, the most immediate impacts of disasters are death and injury but these events can cause physical and psychological trauma that endures in time, often surfacing at a later stage. Hazard events threaten peoples' housing and its surroundings, forcing people to leave their homes. Displacement can be temporal, through semi-permanent relocation, or permanent, when people move to another neighbourhood or elsewhere, to another municipality, region or country.

Even without displacement, individuals, families and community members have to change how they relate and live when businesses and services are limited or fully disrupted. The Global Targets A and B of the Sendai Framework for Disaster Risk Reduction directly monitor the consequences on population, collecting data that would show the trends of some impacts and the possible effects of the measures taken in the aftermath of the disaster.

Subchapter 3.2 is divided in three sections, covering the mentioned direct and indirect impacts. Section 3.2.1, Threat to life, addresses relations between hazards and vulnerabilities of individuals that cause death, injury or health damage across Europe. Section 3.2.2,

Threat to housing and habitat, focuses on the impact of people that has to relocate after a hazardous event, relating socio-economic aspects to the post-disaster displacement. Finally, section 3.2.3 makes an overview of the impacts in the society as a whole, presenting several consequences such as the loss of properties, services and businesses and other intangible impacts related to religion, jobs and family bounds.

The impacts presented are closely related, many of which materialize in the three levels studied (individual, family and community level) in different areas and after some time. These depend on the magnitude and nature of the event but also on the decisions made post-disaster.

“Common short- and long-term procedures to minimise post-event population disturbances should be planned.”

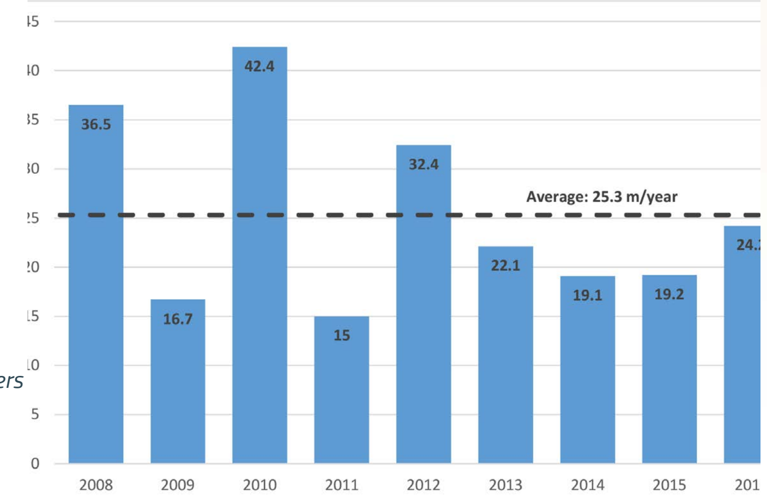
Existing vulnerabilities at individual and community level can unfortunately reinforce if not well considered.

For example, relocation should be well supported by social assistance, as losing the house and having to move somewhere else can have important psychosocial effects on people, which in turn would negatively affect the recovery of those individuals and their circles.

The area impacted can lose workers and people that could actively engage in communal activities, necessary for a fast and inclusive recovery

A SHORT SAMPLE...

What can you find about those arguments Inside **Chapter 3.2** of the next ***“Science for Disaster Risk Management “*** 2020 edition book?



People displacements by year due to disasters

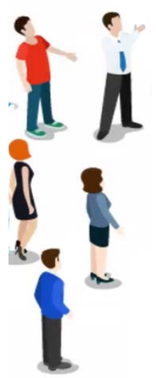
Source: the authors of section 3.2.2 of the Report Science for DRM 2020, using data from the IDMC (2017), Global Report on Internal Displacement, Internal Displacement Monitoring Centre, Geneva, Switzerland.

3.3 Economic Sectors

> "Improving our understanding of the economic impacts of various hazard risks is fundamental for sound and evidence-based disaster risk management, to be implemented by the owners and investors of the assets and businesses, together with other institutions and stakeholders."

The Sendai Framework for Disaster Risk Reduction fixed a set of indicators to follow if the priorities and targets were reached. Global Target C serves to monitor the direct economic loss in relation to the GDP of the country and is calculated considering several assets, among which there is agricultural loss (C-2), other productive assets (C-3) and the housing sector (C-4). Subchapter 3.3 reviews the methods and models used in analysing disaster damage and losses in three economic sectors (named, residential, agriculture and industry and energy), presenting the recent advances and the challenges when carrying out that task.

Direct impacts usually encompass the most immediate damages and losses on the assets due to the materialization of a hazard. Section 3.3.1 Residential proposes as indicators the monetary value of physical damage to buildings but also the cost of cleaning, repairing or demolishing buildings, while section 3.3.2 Agriculture mentions yield losses and cattle mortality. In the case of manufacturing and energy industries, direct impacts can be represented by the physical damage to industries or its impossibility to produce the products or services due to an interruption in their supply chains. Due to the globalised production linkages among industries, the negative effects of a disaster can potentially spread to other regions and countries rapidly.



CHAPTER 3

The successive effects on the market and on society (such as a decrease of buildings in market values or declines in income of the labour forces in the area) are displayed as indirect impact, following the UN terminology.

As highlighted by the authors, special attention should be given when addressing these type of losses and damages to avoid double counting of impacts. The chapter analyses past disasters to display damages and losses, highlighting good practices and critical issues in the assessment of impacts and the management of risk.

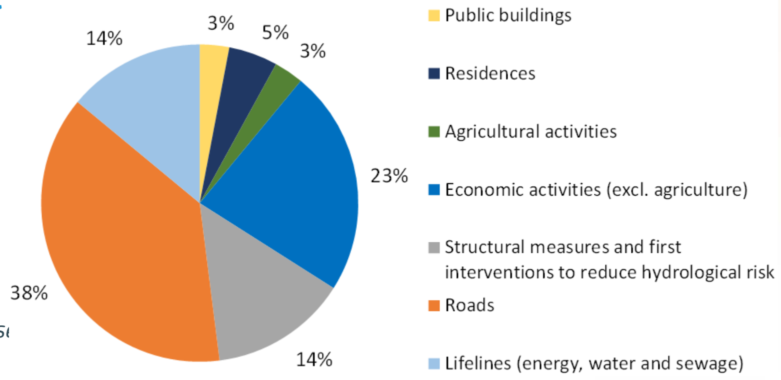
The quantification of impacts is generally used to compensate the owners of the asset(s), although authors express the need to adopt prevention, mitigation, preparedness and adaptation measures before the disaster manifests to ensure a reduction of impacts, especially considering the intensification and increase of occurrence of climate extreme events.

In order to design these types of actions, scientists could take advantage of the data and information that could be systematically collected to reinforce risk assessment methodologies.

Likewise, the quantification of risks and impacts is vital to evaluate the countermeasures that have been implemented.

A SHORT SAMPLE...

What can you find about those arguments Inside **Chapter 3.3** of the next ***"Science for Disaster Risk Management "*** 2020 edition book?



Distribution of losses among the different s tors after the 2012 flood in Umbria

Source: Menoni, S., Molinari, D., Ballio, F., Minucci, G., Atun, F., Berni, N., Pandolfo, C., 2016, 'Flood damage: A model for consistent, complete and multi-purpose scenarios', Natural Hazards and Earth System Sciences, Vol. 16, pp. 2783–2797.

3.4 Critical Infrastructures

Critical infrastructures (CI) provide the essential services that underpin modern societies and support our economies. CIs are complex, adaptive, sociotechnical and highly interdependent systems, although they are often designed in a fragmentary manner. Experience from recent disasters, together with the scientific literature, has provided evidence of the dependencies among critical infrastructures, highlighting pathways of cross-sectoral and cross-border failures.

Subchapter 3.4 aims to broaden the understanding of current and future risks related to critical infrastructure, thus contributing towards a more resilient and sustainable Europe. The subchapter is composed by four sections, which analyse in detail a set of assets and systems at risk and the potential impacts when those are disrupted for any reason. The subchapter focuses on the current vulnerabilities of the CIs, the challenges of the interdependent systems and the options for building resilience into the design of such systems.

> "Our system of production, consumption and day-to-day activities heavily rely on technology, long-range supply lines and interconnected networks, turning our society vulnerable to the impact of potential disruptions."

Section 3.4.1 provides an analysis of the essential concepts and the challenges associated with organisational resilience and continuity management for emergency facilities. Assets such as civil protection coordination centres, hospitals, and fire and police stations represent the first line of defence against disasters and crises. The section first explains the role and duties of emergency facilities to later define the procedures and practices that create operation resilience, describing how cascading effects can undermine both individual operators and the whole organizational resilience.
Section 3.4.2 discusses networked infrastructures, that is, those systems made up of interconnected assets distributed over a large geographical area, or those with numerous interacting components and functions. Energy grids, transport, gas and water supply are examples of networked infrastructures considered in the section. The centrality of these networks provides some degree of resilience by design. Nonetheless, fragilities can appear in each technological layer and in the boundaries of the network, turning these type of infrastructures into channels for the propagation of disasters' consequences, mediators of mitigation actions or both.
Section 3.4.3 addresses risks to society and the environment from damage to core industrial and energy facilities due to man-made and natural hazards using case studies. The section studies how communities can be affected by such incidents, including cascading effects, and proposes how the impacts can be prevented or reduced in the future.

Finally, section 3.4.4 focuses on the role of communication systems and their varying degrees of responsibility for the transfer of information, a critical requisite for emergency response and recovery. The section considers information and communication systems as critical infrastructures themselves. Recent advances in technology are noted in the context of the rapidly developing communication systems and services, including threats like cybercrime and cyberterrorism that are opening up new disaster scenarios with varied impacts.

Our system of production, consumption and day-to-day activities heavily rely on technology, long-range supply lines and interconnected networks, turning our society vulnerable to the impact of potential disruptions.

CHAPTER 3

A SHORT SAMPLE...

What can you find about those arguments
Inside **Chapter 3.4**
of the next
"Science for Disaster Risk Management "
2020 edition book?

Police station in Carlisle before and after flooding
(Source: Wikicommons, author: Philip Halling)

3.5 Environment and ecosystem services

Ecosystem services are the benefits that humans obtain from well-functioning natural, semi-natural or agricultural ecosystems, such as the direct provision of food and water, the regulation of some extreme events and recreational benefits. Because most of these cannot be valued in economic terms, the concept of measuring direct losses is difficult to apply for ecosystem services. Few attempts have been made to assess the economic value of ecosystem services, mainly related to agriculture and forestry.

Ecosystem services have a dual role when talking about disaster impact. On one hand, ecosystem services are affected by hazardous events. Depending on the extent of exposure to a disaster and on the capacity of an ecosystem to cope with disturbances, the ability of a system to deliver its services will reduce. On the other hand, ecosystems can also mitigate disasters. For example, wetlands, floodplains and riparian areas can store water and prevent downstream flooding in periods of extreme precipitation. Well-functioning ecosystems are resistant and resilient to disturbances, protecting societies against disasters.

> The impact of disaster on ecosystem services is dependent on the state of ecosystem degradation. There is a complex and often geographically specific relation between vulnerability to disasters and ecosystem services degradation.

Human activities affect ecosystem services in several ways that, as said, can lead to a loss of human well-being. Research has extensively documented the potential damages related to anthropogenic activities, related to, for example, land-use changes, cropping, deforestation, mining or pollution. These pressures can trigger direct or indirect effects when an extreme event happens.

Moreover, climate warning will lead to unexpected changes in ecosystem functions, like nutrient cycling or water purification, which will increase frequency and/or intensity disasters related to floods, heatwaves and wildfires and its impacts. Authors propose restoration actions and ecosystem-based solutions to protect the ecosystems and enhance their resilience.

3.6 Cultural heritages

The concept of cultural heritage has evolved over time, although it encompasses the assets that a society values as part of their heritage. These can be tangible, such as monuments, sculptures and paintings, or intangible, such as rituals and music. Subchapter 3.6 discusses several issues related to disaster impact assessment in the cultural heritage sector, reviewing existing methodologies and challenges.

When analysing the impact of disasters on these type of assets, authors highlight the limitation of determining an economic value to cultural heritage assets (before an event) and quantifying the damage or loss in value (after a disaster) due to the high level of subjectivity around these analysis. Even when determining the impact economically considering the cost of repairing a physical asset, many intangible uses may be affected, which cannot be estimated economically.

Disasters generate many indirect impacts, such as the interruption of activities taking place at the asset or around it. In some cases, impacts can be quantified economically in loss of income, for example, while in others, like regarding recreational value or loss of social or spiritual value, this task is limited. The identification of indirect impacts is particularly difficult. In the long-term, the interruption of intangible practices and the transmission of traditional knowledge has effects on people, the place and their story, which are difficult to recognize and value. Cultural heritage has varied non-economic impacts on several domains of society, namely community participation, education and social identity and cohesion, that should be well recognized when assessing impact and when managing risk affecting cultural heritage.

Lastly, authors of subchapter 3.6 point out two important elements to reinforce: the availability of baseline data available and the planning of actions to contain losses once a disaster strikes.

> It is necessary to widen the scope of current practices of disaster impact assessment to capture a larger spectrum of economic impacts and to better cover non-economic impacts on society.

4 Communicating risk among all

How to link and integrate the communities and territories to anticipate and face shocks while learning from those experiences is the main topic of risk management addressed in Chapter 4. If communication is effective, the different stakeholders are easily engaged in a constructive dialogue, where both data, information and knowledge is transferred and understood by all of them.

The Chapter considers territories and its communities as networks of diverse and interrelated actors, still nowadays organised in hierarchical and sectoral silos. With this in mind, subchapter 4.1 proposes how to create the conditions to connect those communication networks. The subchapter establishes that participatory and inclusive negotiations are necessary to overcome the challenges of uncertainty about risk, as well as cultural and power differences. Trust emerges as a key factor for collaboration, particularly when disasters move from one level of governance to another or cross borders. At the same time, learning between sectors is vital to create new knowledge, necessary to fully understand the dynamic nature of risk. Both collaboration and learning require of stable governance structures and long-term processes.

> Long-term partnerships create trust that is key for risk communication among stakeholders.

The benefits of engaging citizens in decision-making processes is well recognized by research: policies and projects are easily implemented, improving its effectiveness, because its acceptance increases while possible social conflicts are avoided. European countries are actually shifting towards more integrated and bottom-up approaches in research, education and policy-making. Citizens are probably the most dynamic and diverse group when facing risk and its impacts and the perception of people about risk is determinant to have "active" partners.

Therefore, bottom-up approaches should be tailored considering citizens' needs and opportunities, making possible its participation in all phases of disaster risk management (DRM). Subchapter 4.2, besides analysing these opportunities and challenges, describes various approaches to empower citizens in DRM.

Technology can provide a valuable environment for the social networks interact. Subchapter 4.3 addresses the requirements and possibilities of communication platforms for an agile prevention and response of risk, which link the public and authorities. The subchapter promotes the concept of "risk sensing", an innovative approach for early warning and decision-support systems.

> Innovative communication platforms that combine social and technical aspects should be exploited in order to build resilience.

CHAPTER 4

A SHORT SAMPLE...

What can you find about those arguments Inside **Chapter 4** of the next ***"Science for Disaster Risk Management "*** 2020 edition book?

"The central warning system infrastructure represents the core of such a complete communication system. As example, the suggested architecture should consist of three main components:
- *alerting authorities (AA),*
- *central warning system infrastructure and*
- *public warning subsystems".*

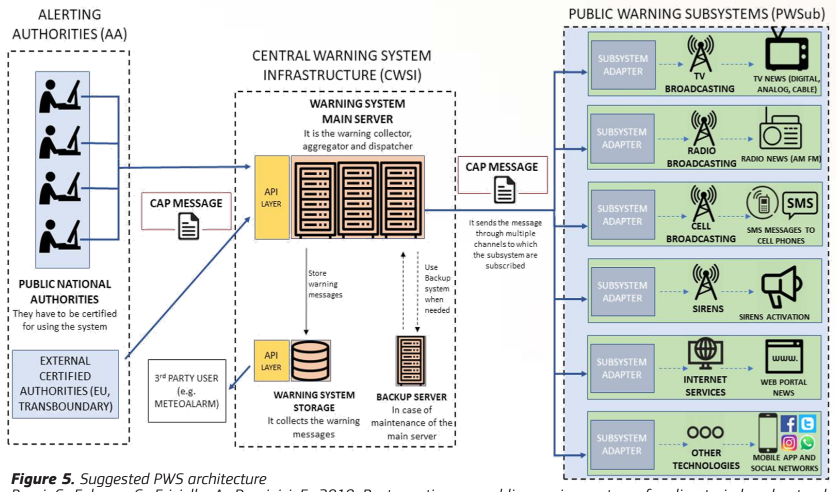


Figure 5. *Suggested PWS architecture*
Rossi, C., Falcone, G., Frisiello, A., Dominici, F., 2018, Best practices on public warning systems for climate-induced natural hazards, https://drmkc.jrc.ec.europa.eu/Portals/0/innovation/SupportSystem/11_Lithuania/JRC_PublicWarningonNaturalHazard_05_PWS_final.pdf.

5 Transferability of knowledge and innovation across the world

CHAPTER 5

The chapter displays a varied set of approaches to reduce risk planned and/or implemented in the EU and abroad, promoting the advantages of identifying and transferring lessons learned at global level. International agreements call for inclusive approaches to make a better use of the knowledge on disaster risk, which is fragmented among different groups and actors. Sharing success stories or lessons learned among these to be reused by others to overcome their particular challenges would enable structures, processes and systems to improve in the decision-making arena.

Communities, organisations and agencies around the globe, and in particular in less developed countries, may have capacities in place (at individual, social and system levels) that are overlooked, which should be identified, protected and shared. Chapter 5 presents, among others, the work of the Indigenous people of New Zealand as community-led response and recovery, the support given to small businesses in the USA to enhance their resilience, the programmes developed at the Pacific North West Economic Region for the protection of critical infrastructure and the education initiative with scholars in Scotland (UK).

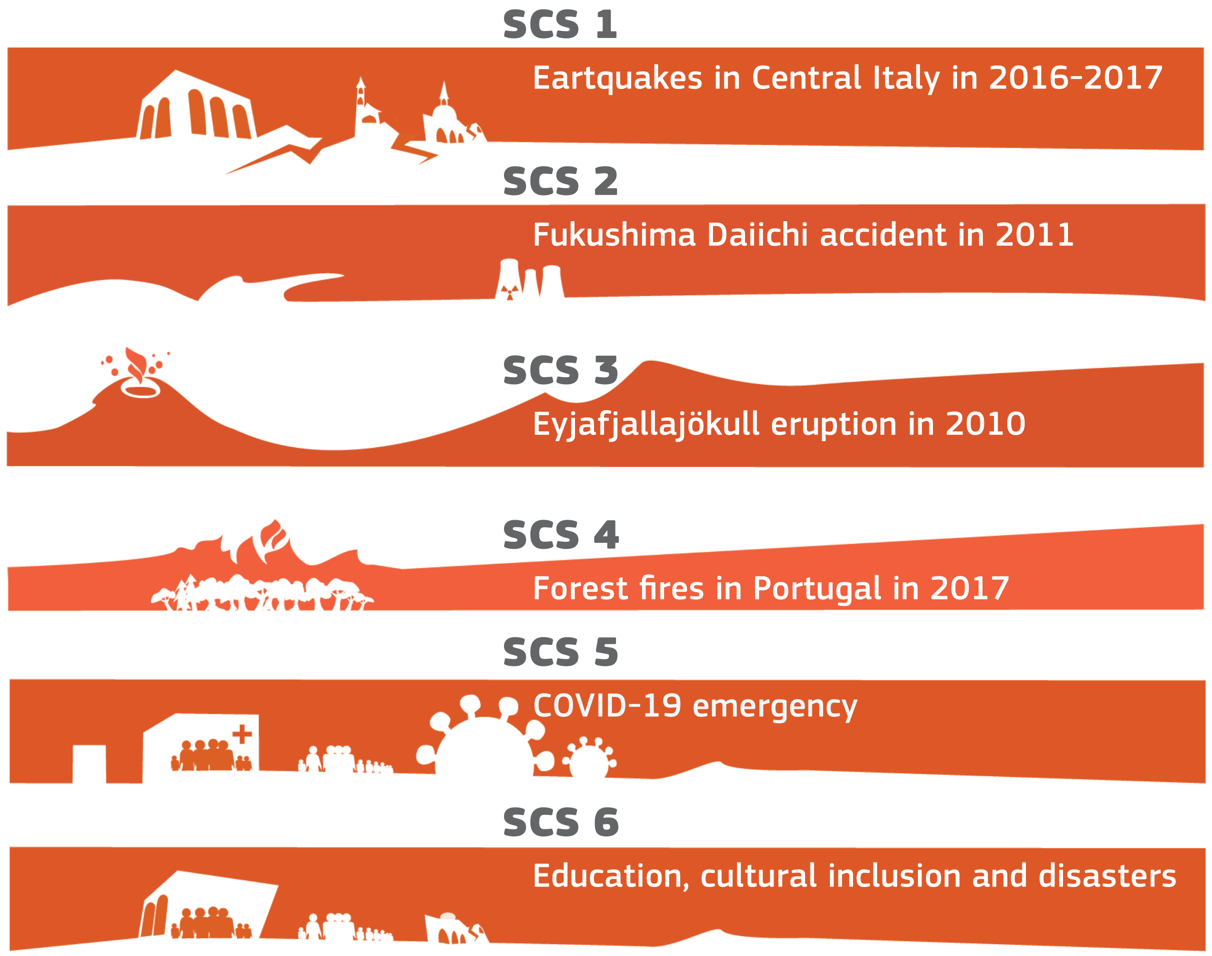
> "A great amount of knowledge of DRM remains fragmented, calling for good practices to be shared and tested more regularly to be applied elsewhere."

The initiatives described show how different groups and actors work to reduce disaster risk related to different DRM phases. Disaster risk reduction requires a system-of-systems approach, considering communities and assets are interconnected and dependent. In line with that, the chapter analyses more in detail two cases related to multi-hazard early warning systems, from its development to its operation.

The lessons learned and best practices could enhance the capacity of the systems as a whole. These could be customised for other locations to be adopted, considering the context-specificities and needs in order to be effective and efficient.

Besides these, special attention should be given to the governance in place and the methods and tools to capture, store, retrieve and finally transfer the cases for these to be really applied by others.

Super Case Studies



LIST OF PARTICIPANTS

Chapter 1. Introduction	
Advisors	
Ylenia Cimmarrusti	European Commission, Joint Research Centre
Tom de Groeve	European Commission, Joint Research Centre
Jozias Blok	European Commission, Directorate-General for International Cooperation and Development (Former)
Madalena Dali	European Commission, Directorate-General for Climate Action
Team of authors	
Ainara Casajus Valles	European Commission, Joint Research Centre
Montserrat Marin Ferrer	European Commission, Joint Research Centre
Ian Clark	European Commission, Joint Research Centre (Former)
Aikaterini Poustourli	International Hellenic University (IHU), Greece
Alessandra Sgobbi	European Commission, Directorate-General for Climate Action
Christofer Ahlgren	European Commission, Directorate-General for Climate Action
Emma Phillips	World Bank Group
Daniel Kull	World Bank Group
Alanna Simpson	World Bank Group
External reviewers	
Mirco Barbero	European Commission, Directorate-General for Environment
Cristina Brailescu	European Commission, Directorate-General for Environment
Pawel Busiakiewicz	European Commission, Directorate-General for Migration and Home Affairs
Chiara Dellapasqua	European Commission, Directorate-General for Agriculture and Rural Development
Laura Indriliunaite	European Commission, Directorate-General for European Civil Protection and Humanitarian Aid Operations
Mariusz Legowski	European Commission, Directorate-General for Agriculture and Rural Development
Ricard Ramon i Sumoy	European Commission, Directorate-General for Agriculture and Rural Development
Katrin Maria Rudolf	European Commission, Directorate-General for Agriculture and Rural Development
Jose Perez Navarrete	European Commission, Directorate-General for Migration and Home Affairs
Gijs Schilthuis	European Commission, Directorate-General for Agriculture and Rural Development
Christian Vincentini	European Commission, Directorate-General for Agriculture and Rural Development
Alessandra Zampieri	European Commission, Joint Research Centre

Chapter 2. Integrating the risk management cycle	
Subchapter 2.1 Risk Assessment	
Advisors	
Clemens Neuhold	Federal Ministry of Agriculture, Regions and Tourism, Austria
Eugenio Gil	Consejo de Seguridad Nacional, Spain (Former) / International Atomic Energy Agency (IAEA)
Alik Ismail-Zadeh	Karlsruhe Institute of Technology, Germany / the International Science Council, France
Team of authors	
Coordinating Lead Authors	
Gerassimos A. Papadopoulos	International Society for the Prevention & Mitigation of Natural Hazards, Greece
Todor Tagarev	Bulgarian Academy of Sciences, Bulgaria
Lead Author	
Michael Hagenlocher	United Nations University, Germany
Contributing Authors	
Annegret Thieken	University of Potsdam, Germany
Stefan Schneiderbauer	United Nations University, Germany/Eurac Research, Italy
Ignacio Aguirre Ayerbe	IHCantabria, Spain
Pavel Dobes	Technical University of Ostrava, Czechia
Amy Donovan	University of Cambridge, UK
Claudia Morsut	University of Stavanger, Norway
Nicholas Paris	Cyprus Civil Defence, Cyprus
Lydia Pedoth	Eurac Research, Italy
Fahim Tonmoy	Griffith University, Australia
External reviewers	
Ajin R.S	Kerala State Disaster Management Authority, India
Francesco Fusto	Regional Environmental Protection Agency of Calabria, Italy
Leendert Gooijer	National Institute for Public Health and the Environment (RIVM), Netherlands
Helene Jacot des Combes	National Disaster Management Office, Marshall Islands
Danai Kazantzidou-Firtinidou	Center for Security Studies (KEMEA), Greece
Carlos Mendes Lucio	Portuguese National Authority for Emergencies and Civil Protection (ANEPC), Portugal
Petre-Cornel Min	National Commission for Nuclear Activities Control (CNCAN), Romania

Gregory Pearn	NIRAS - IP Consult, Germany
Roger Street	University of Oxford, UK
Dusan Zupka	École des mines d'Alès, France

Subchapter 2.2 Risk Management Planning	
Advisors	
Clemens Neuhold	Federal Ministry of Agriculture, Regions and Tourism, Austria
Eugenio Gil	Consejo de Seguridad Nacional (former), Spain / International Atomic Energy Agency (IAEA)
Sorin Cursaru	European Commission, Joint Research Centre
Team of authors	
Coordinating Lead Authors	
Gerassimos A. Papadopoulos	International Society for the Prevention & Mitigation of Natural Hazards, Greece
Todor Tagarev	Bulgarian Academy of Sciences, Bulgaria
Lead Author	
Richard Sluizas	University of Twente, Netherlands
Contributing Authors	
Peter Jackovics	National Directorate General for Disaster Management, Hungary
Solveig Thorvaldsdottir	Rainrace, Iceland
Karolina Kalinowska	European Commission, Directorate-General for European Civil Protection and Humanitarian Aid Operations
Pavlos Tyrologou	European Federation of Geologists, Greece
Christian Resch	Resilience Solutions International, Austria
Sergio Castellari	European Environment Agency
Stefan Greiving	Technical University of Dortmund, Germany
External reviewers	
Dimitrios Alexandris	General Secretariat for Civil Protection, Greece
Funda Atun-Girgin	University of Twente, Netherlands
Francesco Fusto	Regional Environmental Protection Agency of Calabria, Italy
Artemis Galani	General Secretariat for Civil Protection, Greece
Helene Jacot des Combes	National Disaster Management Office, Marshall Islands
Carlos Mendes Lucio	Portuguese National Authority for Emergencies and Civil Protection (ANEPC), Portugal
Petre-Cornel Min	National Commission for Nuclear Activities Control (CNCAN), Romania
Gregory Pearn	NIRAS - IP Consult, Germany
Dan Serbanescu	Societatea Nuclearelectrica SA, Romania

Magda Stepanyan	Risk Society
Roger Street	University of Oxford, UK

Subchapter 2.3 Implementing risk management measures	
Advisors	
Clemens Neuhold	Federal Ministry of Agriculture, Regions and Tourism, Austria
Eugenio Gil	Consejo de Seguridad Nacional (former), Spain / International Atomic Energy Agency (IAEA)
Sorin Cursaru	European Commission, Joint Research Centre
Team of authors	
Coordinating Lead Authors	
Gerassimos A. Papadopoulos	International Society for the Prevention & Mitigation of Natural Hazards, Greece
Todor Tagarev	Bulgarian Academy of Sciences, Bulgaria
Lead Authors	
Mikio Ishiwatari	University of Tokyo, Japan
Eduardo Gallego	Universidad Politecnica de Madrid, Spain
Contributing Authors	
Maureen Wood	European Commission, Joint Research Centre
Lydia Cumiskey	Middlesex University, UK
Roger S. Pulwarty	US National Oceanic and Atmospheric Administration, USA
Matthieu Meerpoel	Catholic University of Lille, France
Agostino Goretti	Italian Civil Protection Department, Italy
External reviewers	
Dimitrios Alexandris	General Secretariat for Civil Protection, Greece
Artemis Galani	General Secretariat for Civil Protection, Greece
Helene Jacot des Combes	National Disaster Management Office, Marshall Islands
Peter Lauwe	Federal Office of Civil Protection and Disaster Assistance (BBK), Germany
Carlos Mendes Lucio	Portuguese National Authority for Emergencies and Civil Protection (ANEPC), Portugal
Petre-Cornel Min	National Commission for Nuclear Activities Control (CNCAN), Romania
Gregory Pearn	NIRAS - IP Consult, Germany
Roger Street	University of Oxford, UK
Kathleen van Heuverswyn	KULeuven, Belgium

Chapter 3. Assets at risk and potential impacts

Subchapter 3.1 Methodologies for Disaster Impact Assessment	
Advisors	
Xu Tang	World Meteorological Organization (WMO) / Fudan University, China
Peter Hoeppe	Munich Re, Germany (Former) / Nanyang Technological University, Singapore
Gerald Fleming	Meteo Consultancy, Ireland
Team of authors	
Lead Authors	
Abhinav Walia	University of Newcastle, Australia
Scira Menoni	Politecnico di Milano, Italy
Contributing Authors	
Marcelo Farah Dell'Aringa	Università del Piemonte Orientale, Italy
Matus Bakon	insar.sk Ltd, Slovakia
Martin Rovnak	insar.sk Ltd, Slovakia
Kristian Milenov	Agency of Sustainable Development and Eurointegration – Ecoregions (ASDE), Bulgaria
Assen Dyulgerov	Agency of Sustainable Development and Eurointegration – Ecoregions (ASDE), Bulgaria
Radko Radkov	Agency of Sustainable Development and Eurointegration – Ecoregions (ASDE), Bulgaria
Leo Posthuma	National Institute for Public Health and the Environment, Netherlands
Todor Shopov	Sofia University "St. Kliment Ohridski", Bulgaria
Krasimir Markov	University of Telecommunications and Post, Bulgaria / Institute on Information Theories and Applications, Bulgaria
Cees van de Guchte	Deltares, The Netherlands
Monica Altamirano	Deltares, The Netherlands
Dennis Wagenaar	Deltares, The Netherlands
Judith Kaspersma	Deltares, The Netherlands
External reviewers	
Ajin R.S	Kerala State Disaster Management Authority, India
Graham Brewer	University of Newcastle, Australia
Marc Erlich	freelance consultant
Allan Lavell	Latin American Social Science Faculty (FLACSO)
Carlos Mendes Lucio	Portuguese National Authority for Emergencies and Civil Protection (ANEPC), Portugal
Angela Potenciano Heras	National School of Civil Protection, Spain / Universidad Complutense de Madrid, Spain
Roger Street	University of Oxford, UK

Chapter 3. Assets at risk and potential impacts

Subchapter 3.2 Population

3.2.1 Threat to life	
Advisor	
Daniele Ehrlich	European Commission, Joint Research Centre
Team of authors	
Coordinating Lead Author	
Thomas Kemper	European Commission, Joint Research Centre
Lead Authors	
Sergio Freire	European Commission, Joint Research Centre
Olga Petrucci	Consiglio Nazionale delle Ricerche, Istituto di Ricerca per la Protezione Idrogeologica (CNR-IRPI), Italy
Contributing Authors	
Paul T. J. Scheepers	Radboudumc, Nijmegen/Public Health Service Tilburg, Netherlands
Jeroen M. M. Neuvel	National Institute for Public Health and the Environment, Netherlands
Joacim Rocklöv	Umeå University, Sweden
Christofer Åström	Umeå University, Sweden
External reviewers	
Yung-Fang Chen	Coventry University, UK
Susan Cutter	University of South Carolina, USA
Gábor Földvári	Centre for Ecological Research, Hungary
Barbara Juen	University of Innsbruck / Austrian Red Cross, Austria
Danai Kazantzidou-Firtinidou	Center for Security Studies (KEMEA), Greece
Kim Lintrup	Frederiksborg Brand & Redning, Denmark
Cian O'Brien	Health Service Executive, Ireland
Kathrin Renner	Eurac Research, Italy
Stoyan Stoyanov	Academy of the Ministry of Interior, Bulgaria
Erich Striessnig	Wittgenstein Centre for Demography and Global Human Capital, Austria
Valery Todorov	Academy of the Ministry of Interior, Bulgaria

3.2.2 Threat to housing and habitat	
Advisor	
Daniele Ehrlich	European Commission, Joint Research Centre
Team of authors	
Coordinating Lead Author	
Thomas Kemper	European Commission, Joint Research Centre
Lead Authors	
Marcello Schiavina	European Commission, Joint Research Centre

Giulio Zuccaro	University of Naples Federico II, Italy
Contributing Authors	
Eve Coles	Leeds University, UK
Daniela De Gregorio	University of Naples Federico II, Italy
Lucy Easthope	University of Bath, UK
Daniel F. Lorenz	Freie Universität Berlin, Germany
Oriol Monserrat	Centre Tecnològic de Telecomunicacions de Catalunya, Spain
Filomena Papa	Civil Protection Department, Italy
Jair Torres	UNESCO, France
Marjan van Meerloo	European Commission, Directorate-General for Research and Innovation
External reviewers	
Ajin R.S	Kerala State Disaster Management Authority, India
Daniela Baleva	"G. S. Rakovski" National Defence College, Bulgaria
Yung-Fang Chen	Coventry University, UK
Susan Cutter	University of South Carolina, USA
Danai Kazantzidou-Firtinidou	Center for Security Studies (KEMEA), Greece
Paul O'Hare	Manchester Metropolitan University, UK
Angeliki Paidakaki	KU Leuven, Belgium
Angela Potenciano Heras	National School of Civil Protection, Spain / Universidad Complutense de Madrid, Spain
Magali Reghezza-Zitt	Ministry of Higher Education, Research and Innovation, France
Kathrin Renner	Eurac Research, Italy
Stoyan Stoyanov	Academy of the Ministry of Interior, Bulgaria
Valery Todorov	Academy of the Ministry of Interior, Bulgaria

3.2.3 Threat to society	
Advisor	
Daniele Ehrlich	European Commission, Joint Research Centre
Team of authors	
Coordinating Lead Author	
Thomas Kemper	European Commission, Joint Research Centre
Lead Authors	
Aslan Mehmet Çoşkun	Disaster and Emergency Management Authority, Turkey
Ivan Frigerio	University of Milano-Bicocca,Italy
Contributing Authors	
Marcelo Farah Dell'Aringa	Università del Piemonte Orientale, Italy
Nils Vandenbroucke	VIVES University College, Belgium
Veit Blauhut	University of Freiburg, Germany

External reviewers	
Ajin R.S	Kerala State Disaster Management Authority, India
Daniela Baleva	Rakovski National Defence College, Bulgaria
Yung-Fang Chen	Coventry University, UK
Susan Cutter	University of South Carolina, USA
Marc Erlich	freelance consultant
Vlatko Jovanovski	Disaster Preparedness and Prevention Initiative for South Eastern Europe
Angela Potenciano Heras	National School of Civil Protection, Spain / Universidad Complutense de Madrid, Spain
Magali Reghezza-Zitt	Ministry of Higher Education, Research and Innovation, France
Kathrin Renner	Eurac Research, Italy
Stoyan Stoyanov	Academy of the Ministry of Interior, Bulgaria
Valery Todorov	Academy of the Ministry of Interior, Bulgaria

Chapter 3. Assets at risk and potential impacts

Subchapter 3.3 Economic sectors

3.3.1 Residential	
Advisor	
Anna Santoro	European Commission, Joint Research Centre
Team of authors	
Coordinating Lead Author	
Jaroslav Mysiak	Centro Euro-Mediterraneo sui Cambiamenti Climatici - CMCC
Lead Authors	
Daniela Molinari	Politecnico di Milano, Italy
Georgios Tsionis	European Commission, Joint Research Centre
Contributing Authors	
Adamantia Athanasopoulou	European Commission, Joint Research Centre
Dionysios Bournas	European Commission, Joint Research Centre
Roxana Ciurean	British Geological Survey, United Kingdom
Daniela De Gregorio	University of Naples Federico II, Italy
Mattia Leone	University of Naples Federico II, Italy
Tiziana Rossetto	University College London, United Kingdom
Maria Luísa Sousa	European Commission, Joint Research Centre
Giulio Zuccaro	University of Naples Federico II, Italy
External reviewers	
Allan Beltran Hernandez	University of Birmingham, UK
Chandra Bhakuni	Freelance consultant, India
Lee Bosher	Loughborough University, UK
Anna Rita Manca	European Commission, Joint Research Centre
Michio Naoi	Keio University, Japan
Srinath Perera	Western Sydney University, Australia
Anders Rimne	Boverket - National Board of Housing, Building and Planning, Sweden
Emilyn Witt	Tallinn University of Technology, Estonia

3.3.2 Agriculture	
Advisor	
Anna Santoro	European Commission, Joint Research Centre
Team of authors	
Coordinating Lead Author	
Jaroslav Mysiak	Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC), Italy
Lead Author	
Andrea Toreti	European Commission, Joint Research Centre
Contributing Authors	
Simona Bassu	European Commission, Joint Research Centre
Dioniso Perez Blanco	Universidad de Salamanca, Spain / Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy
Fabian Capitanio	University of Naples Federico II, Italy
Rodrigo Rudge Ramos Ribeiro	Getulio Vargas Foundation, Brazil
Daniela Molinari	Politecnico di Milano, Italy
Heidi Webber	Leibniz Centre for Agricultural Landscape Research, Germany
External reviewers	
Nicolas Bauduceau	CCR, France
Helena Kahiluoto	LUT University, Finland
Blaz Kurnik	European Environment Agency (EEA)
Fabio Santeramo	University of Foggia, Italy
Giulia Vico	Swedish University of Agricultural Sciences (SLU), Sweden
Slavica Zec	European Commission, Joint Research Centre

3.3.3 Industry and energy	
Advisor	
Anna Santoro	European Commission, Joint Research Centre
Team of authors	
Coordinating Lead Author	
Jaroslav Mysiak	Centro Euro-Mediterraneo sui Cambiamenti Climatici - CMCC
Lead Author	
Yasuhide Okuyama	University of Kitakyushu, Japan
Contributing Authors	
Serkan Girgin	University of Twente, the Netherlands
María Isabel Martínez Torre-Enciso	Universidad Autónoma de Madrid, Spain
Zdenko Šimić	European Commission, Joint Research Centre
External reviewers	
Daniela Baleva	"G. S. Rakovski" National Defence College, Bulgaria
Serena Fatica	European Commission, Joint Research Centre
Fadi Hamdan	DRM Centre, Lebanon

Chapter 3. Assets at risk and potential impacts

Subchapter 3.4 Critical Infrastructures

3.4.1 Emergency facilities

Advisors	
Georgios Giannopoulos	European Commission, Joint Research Centre
Wolfgang Raskob	Karlsruhe Institute of Technology, Germany
Pierre Kockerols	European Commission, Joint Research Centre
Team of authors	
Coordinating Lead Authors	
John Agius	Critical Infrastructure Protection Directorate (CIPD), Malta
Georgios Karagiannis	European Commission, Joint Research Centre
Lead Author	
Gianluca Pescaroli	University College London, UK
Contributing Authors	
David Alexander	University College London, UK
Virginia Murray	Public Health England, UK
External reviewers	
Dimitrios Alexandris	General Secretariat for Civil Protection, Greece
Daniela Baleva	“G. S. Rakovski“ National Defence College, Bulgaria
Danai Kazantzidou-Firtinidou	Center for Security Studies (KEMEA), Greece
Peter Lauwe	Federal Office of Civil Protection and Disaster Assistance (BBK), Germany
Kim Lintrup	Frederiksborg Brand & Redning, Denmark
Joel Joris van de Klundert	Erasmus University Rotterdam, The Netherlands

3.4.2 Network infrastructures

Advisors	
Georgios Giannopoulos	European Commission, Joint Research Centre
Wolfgang Raskob	Karlsruhe Institute of Technology, Germany
Pierre Kockerols	European Commission, Joint Research Centre
Team of authors	
Coordinating Lead Authors	
John Agius	Critical Infrastructure Protection Directorate – CIPD, Malta
Georgios Karagiannis	European Commission, Joint Research Centre
Lead Authors	
Luca Galbusera	European Commission, Joint Research Centre
Marianthi Theocharidou	European Commission, Joint Research Centre
Contributing Authors	
Oriol Monserrat	Centre Tecnològic de Telecomunicacions de Catalunya, Spain
Petr Novotny	Technical University of Ostrava, Czechia
Giovanni Sansavini	ETH Zürich, Switzerland
Bozidar Stojadinovic	ETH Zürich, Switzerland
External reviewers	
Stefano Bracco	Agency for the Cooperation of Energy Regulators (ACER), Slovenia
Danai Kazantzidou-Firtinidou	Center for Security Studies (KEMEA), Greece
Peter Lauwe	Federal Office of Civil Protection and Disaster Assistance (BBK), Germany
Ricardo Messias	EDP Distribuiçao, Portugal
Eleonora Papadimitriou	Delft University of Technology, Netherlands
David Rehak	Technical University of Ostrava, Czechia
Margarita Zango Pascual	Universidad Pablo de Olavide de Sevilla, Spain

3.4.3 Core industrial and energy facilities

Advisors	
Georgios Giannopoulos	European Commission, Joint Research Centre
Wolfgang Raskob	Karlsruhe Institute of Technology, Germany
Pierre Kockerols	European Commission, Joint Research Centre
Team of authors	
Coordinating Lead Authors	
John Agius	Critical Infrastructure Protection Directorate – CIPD, Malta
Georgios Karagiannis	European Commission, Joint Research Centre
Lead Author	
Elisabeth Krausmann	European Commission, Joint Research Centre
Contributing Authors	
Athanasios Fourtounas	Joint Logistics Support Group NATO, Greece
Serkan Girgin	University of Twente, the Netherlands
Miguel Angel Hernandez Ceballos	European Commission, Joint Research Centre
Daniel Jung	European Commission, Joint Research Centre
Ernesto Salzano	University of Bologna, Italy
Zdenko Šimić	European Commission, Joint Research Centre
External reviewers	
Artemis Galani	General Secretariat for Civil Protection, Greece
Franziska Hirsch	UNECE
Nima Khakzad Rostami	Delft University of Technology, Netherlands
Peter Lauwe	Federal Office of Civil Protection and Disaster Assistance (BBK), Germany
Sergiusz Ludwiczak	UNECE
Olivier Salvi	INERIS Developpement
Francisc Senzaconi	General Inspectorate for Emergency Situations, Romania

3.4.4 Communication systems	
Advisors	
Georgios Giannopoulos	European Commission, Joint Research Centre
Wolfgang Raskob	Karlsruhe Institute of Technology, Germany
Pierre Kockerols	European Commission, Joint Research Centre
Team of authors	
Coordinating Lead Authors	
John Agius	Critical Infrastructure Protection Directorate – CIPD, Malta
Georgios Karagiannis	European Commission, Joint Research Centre
Lead Author	
Kalpana Chaudhari	Institute for Sustainable Development and Research, India / Shah and Anchor Kutchhi Engineering College, India
Contributing Authors	
David Lund	Public Safety Communication Europe Forum, Belgium
Paruthummootil Jacob Philip	Institute for Sustainable Development and Research, India
Pasquale De Toro	University of Naples Federico II, Italy
Maria Cerreta	University of Naples Federico II, Italy
Jose Luis Marin	Applications in Advance Computing, Grupo AIA, Spain
Milenko Halat	Applications in Advance Computing, Grupo AIA, Spain
External reviewers	
Yung-Fang Chen	Coventry University, UK
David Hutchison	Lancaster University, UK
Peter Lauwe	Federal Office of Civil Protection and Disaster Assistance (BBK), Germany
Alexander Preinerstorfer	AIT Austrian Institute of Technology, Austria
Dimiter Velev	University of National and World Economy, Bulgaria

Chapter 3. Assets at risk and potential impacts

Subchapter 3.5 Environment and ecosystem services	
Advisors	
Joachim Maes	European Commission, Joint Research Centre
Yuri Bruinen de Bruin	European Commission, Joint Research Centre
Team of authors	
Lead Authors	
Alfred de Jager	European Commission, Joint Research Centre
Sara Peláez	University of Limerick, Ireland
Contributing Authors	
Johannes Amate Belle	DiMTEC, South Africa
Veit Blauhut	University of Freiburg, Germany
Elisabeth Krausmann	European Commission, Joint Research Centre
Nina Nikolić	University of Belgrade, Serbia
Karoliina Pilli Sihvola	Finnish Meteorological Institute, Finland
Alessandra La Notte	European Commission, Joint Research Centre
Jordi Cortina	University of Alicante, Spain
External reviewers	
András Báldi	Centre for Ecological Research, Hungary
Mirco Barbero	European Commission, Directorate-General for Environment
Cristina Brailescu	European Commission, Directorate-General for Environment
Vena Pearl Bongolan	UP Diliman, Philippines
Zuzana Harmáčková	Czech Academy of Sciences, Czechia
Ulrich Schwarz	Fluvius, Austria
Deepthi Wickramasinghe	University of Colombo, Sri Lanka

Chapter 3. Assets at risk and potential impacts

Subchapter 3.6 Cultural heritage	
Advisor	
Sergio Olivero	Politecnico di Torino, Italy
Team of authors	
Lead Author	
Xavier Romão	University of Porto, Portugal
Contributing Authors	
Esmeralda Paupério	University of Porto, Portugal
Oriol Monserrat	Centre Tecnològic de Telecomunicacions de Catalunya, Spain
Theodoros Rousakis	Democritus University of Thrace, Greece
Pilar Montero Vilar	Complutense University of Madrid
External reviewers	
Isabelle Anatole-Gabriel	UNESCO
Giovanni Boccardi	UNESCO
Lejla Hadžić	Cultural Heritage without Borders, Albania
Mario Hernandez	International Society for Digital Earth (ISDE)
Elena Mamani	Cultural Heritage without Borders, Albania
Ionut Cristi Nicu	Norwegian Institute for Cultural Heritage Research, Norway
Mohammad Ravankhah	University of Stuttgart

Chapter 4. Communicating risk among all

Subchapter 4.1 Linking actors, sectors and governance levels	
Advisors	
Daniela di Bucci	Civil Protection Department, Italy
Sálvano Briceño	United Nations Office for Disaster Risk Reduction (UNDRR) (Former) / International Science Council (ISC/ROLAC)
Kevin Blanchard	DRR Dynamics, UK
Wolfgang Raskob	Karlsruhe Institute of Technology, Germany
Team of authors	
Coordinating Lead Authors	
Kees Boersma	Vrije Universiteit Amsterdam, Netherland
Cristina Martelli	University of Florence, Italy
Lead Authors	
Yuri Bruinen de Bruin	European Commission, Joint Research Centre
Ana Lisa Vetere Arellano	European Commission, Joint Research Centre
Contributing Authors	
Chloe Begg	Helmholtz-Zentrum für Umweltforschung (UFZ), Germany
Nicolas Dechy	Institut de Radioprotection et de Sûreté Nucléaire (IRSN), France
Amy Donovan	University of Cambridge, UK
Karolina Kalinowska	European Commission, Directorate-General for European Civil Protection and Humanitarian Aid Operations
Boris Petrenj	Politechnico di Milano, Italy
Christian Resch	Resilience Solutions International, Austria
Tuuli Tulonen	Finnish Safety and Chemicals Agency (TUKES), Finalnd
External reviewers	
Yung-Fang Chen	Coventry University, UK
Marc Erlich	freelance consultant
Paul O'Hare	Manchester Metropolitan University, UK
Dan Serbanescu	Societatea Nuclearelectrica SA, Romania
Kathleen van Heuverswyn	KULeuven, Belgium
Jolanta Zubrickaite	European Commission, Joint Research Centre

Subchapter 4.2 Citizen participation and public awareness	
Advisors	
Daniela di Bucci	Civil Protection Department, Italy
Sálvano Briceño	United Nations Office for Disaster Risk Reduction (UNDRR) (Former) / International Science Council (ISC/ROLAC)
Kevin Blanchard	DRR Dynamics, UK
Heikki Laurikainen	The Finnish National Rescue Association, Finland
Team of authors	
Coordinating Lead Authors	
Kees Boersma	Vrije Universiteit Amsterdam, Netherland
Cristina Martelli	University of Florence, Italy
Lead Author	
Liesbeth Claassen	National Institute for Public Health and the Environment (RIVM), Netherlands
Contributing Authors	
Kalliopi Sapountzaki	Harokopion University of Athens, Greece
Anna Scolobig	Environmental Governance and Territorial Development Institute at the University of Geneva, Switzerland
Tanja Perko	Belgian nuclear research centre SCK CEN and University of Antwerp, Belgium
Slawomir Górski	Ministry of the Interior and Administration, Poland
Danuta Kazmierczak	Pedagogical University Krakow, Poland
Susan Anson	Trilateral Research, London, UK
Fabio Carnelli	University of L'Aquila, Italy
Remy Bossu	European-Mediterranean Seismological Centre, France
Carlos Sousa Oliveira	Instituto Superior Tecnico, University of Lisbon, Portugal
External reviewers	
Funda Atun-Girgin	University of Twente, Netherlands
Daniel Auferbauer	AIT Austrian Institute of Technology, Austria
Yung-Fang Chen	Coventry University, UK
Ann Enander	Swedish Defence University, Sweden
Susanna Falsaperla	Istituto Nazionale di Geofisica e Vulcanologia, Italy
Michael O'Grady	University College Dublin, Ireland
Jolanta Zubrickaite	European Commission, Joint Research Centre

Subchapter 4.3 Integrating tools for prevention and response communication systems	
Advisors	
Daniela di Bucci	Civil Protection Department, Italy
Sálvano Briceño	United Nations Office for Disaster Risk Reduction (UNDRR) (Former) / International Science Council (ISC/ROLAC)
Kevin Blanchard	DRR Dynamics, UK
Christian Morgner	University of Leicester, UK
Team of authors	
Coordinating Lead Authors	
Kees Boersma	Vrije Universiteit Amsterdam, Netherland
Cristina Martelli	University of Florence, Italy
Lead Author	
Stefan Pickl	German Committee for Disaster Reduction (DKKV) / Universität der Bundeswehr München, Germany
Contributing Authors	
Gilles Grandjean	Bureau de Recherches Géologiques et Minières, Risk & Prevention (BRGM), France
Piotr Kolmann	The Main School of Fire Service, Poland
Miodrag Stručić	European Commission, Joint Research Centre
Gemma Musacchio	Istituto Nazionale di Geofisica e Vulcanologia, Italy
Claudio Rossi	Istituto Superiore Mario Boella, Italy
External reviewers	
Monica Viorela Alexandru	Ministry of Research and Innovation, Romania
Yung-Fang Chen	Coventry University, UK
Marc Erlich	freelance consultant
Marco Manso	EDGENEERING, Portugal
Michael O'Grady	University College Dublin, Ireland
Alexander Preinerstorfer	AIT Austrian Institute of Technology, Austria
Dimiter Velev	University of National and World Economy, Bulgaria

Chapter 5. Global Synergies of EU Expertise: Transferability of Knowledge and Innovation Across the World	
Advisors	
Tom de Groeve	European Commission, Joint Research Centre
Marc Gordon	United Nations Office for Disaster Risk Reduction (UNDRR)
Olvido Guzman	OECD Nuclear Energy Agency
Team of authors	
Lead Author	
Bapon (SHM) Fakhruddin	Tonkin + Taylor, New Zealand
Contributing Authors	
Jair Torres	UNESCO, France
Boris Petrenj	Politecnico Di Milan, Italy
Laura Tilley	Tonkin + Taylor, New Zealand
External reviewers	
Chandra Bhakuni	Freelance consultant, India
John Fien	RMIT University, Australia
Salla Himberg	Red Cross EU Office, Belgium
Helene Jacot des Combes	National Disaster Management Office, Marshall Islands
Thorsten Klose-Zuber	German Federal Foreign Office, Germany
Gregory Pearn	NIRAS - IP Consult, Germany
David Sochor	Swiss Agency for Development and Cooperation (SDC), Switzerland
Magda Stepanyan	Risk Society
Massimo Farrugia	European External Action Service (EEAS)

SCS 1. Earthquakes in Central Italy in 2016-2017	
Team of authors	
Lead Authors	
Daniela Di Bucci	Civil Protection Department, Italy
Mauro Dolce	Civil Protection Department, Italy
Contributing Authors	
Dionysios Bournas	European Commission, Joint Research Centre
Didier Combescure	French Association of Earthquake Engineering, France
Daniela De Gregorio	University of Naples Federico II, Italy
Luca Galbusera	European Commission, Joint Research Centre
Mattia Leone	University of Naples Federico II, Italy
Filomena Papa	Civil Protection Department, Italy
Xavier Romão	Universidade do Porto, Portugal
Massimo Sargolini	University of Camerino, Italy
Marianthi Theocharidou	European Commission, Joint Research Centre
Giulio Zuccaro	University of Naples Federico II, Italy
External reviewers	
Danai Kazantzidou-Firtinidou	Center for Security Studies (KEMEA), Greece
Chandra Bhakuni	Freelance consultant, India
Internal reviewers	
Adamantia Athanasopoulou	European Commission, Joint Research Centre
Remy Bossu	European-Mediterranean Seismological Centre, France
Oriol Monserrat	Centre Tecnològic de Telecomunicacions de Catalunya, Spain
Esmeralda Paupério	University of Porto, Portugal

SCS 2. Fukushima Daiichi accident in 2011

Team of authors	
Lead Author	
Wolfgang Raskob	Karlsruhe Institute of Technology, Germany
Contributing Authors	
Nicolas Dechy	Institut de Radioprotection et de Sûreté Nucléaire (IRSN), France
Amy Donovan	University of Cambridge, UK
Eduardo Gallego	Universidad Politecnica de Madrid, Spain
Kenji Nanba	Fukushima University, Japan
Xavier Romão	Universidade do Porto, Portugal
Cristina P. Tanzi	National Institute for Public Health and the Environment (RIVM), Netherlands
Marcus Wiens	Karlsruhe Institute of Technology, Germany
Miguel Angel Hernandez Ceballos	European Commission, Joint Research Centre
External reviewers	
Alexander Fekete	TH Köln
Petre-Cornel Min	National Commission for Nuclear Activities Control (CNCAN), Romania
Dan Serbanescu	Societatea Nuclearelectrica SA, Romania
Athanasios Sfestos	National Centre of Scientific Research “Demokritos”, Greece
Dimiter Velev	University of National and World Economy, Bulgaria
Internal reviewers	
Mikio Ishiwatari	University of Tokyo, Japan
Ernesto Salzano	University of Bologna, Italy
Zdenko Šimić	European Commission, Joint Research Centre

SCS 3. Eyjafjallajökull eruption in 2010

Team of authors	
Lead Authors	
Gudrun Petursdottir	University of Iceland, Iceland
Uta Reichardt	University of Iceland, Iceland
Contributing Authors	
Deanne Bird	University of Iceland, Iceland
Amy Donovan	University of Cambridge, UK
Guðrún Gísladóttir	University of Iceland, Iceland
Arna Hauksdottir	University of Iceland, Iceland
Gudrun Johannesdottir	Department of Civil Protection and Emergency Management, Iceland
Freysteinn Sigmundsson	University of Iceland, Iceland
Edda Bjork Thordardottir	University of Iceland, Iceland
Gudmundur F. Ulfarsson	University of Iceland, Iceland
External reviewers	
Monica Viorela Alexandru	Ministry of Research and Innovation, Romania
Riccardo Biondi	Università degli Studi di Padova, Italy
Athanasios Sfestos	National Centre of Scientific Research “Demokritos”, Greece
Internal reviewers	
Ernesto Salzano	University of Bologna, Italy

SCS 4. Forest fires in Portugal in 2017

Team of authors	
Lead Author	
Jesús San Miguel Ayanz	European Commission, Joint Research Centre
Contributing Authors	
Duarte Oom	European Commission, Joint Research Centre
Tomas Artès	European Commission, Joint Research Centre
Domingos X. Viegas	Universidade de Coimbra, Portugal
Paulo Fernandes	Universidade de Trás-os-Montes e Alto Douro, Portugal
Nicolas Faivre	European Commission, Directorate-General for Research and Innovation (DG RTD)
Sergio Freire	European Commission, Joint Research Centre
Peter Moore	Food and Agriculture Organization of the United Nations, Italy
Francisco Rego	University of Lisbon, Portugal
Marc Castellnou	Catalan Fire and Rescue Service, Spain/ Pau Costa Foundation, Spain
External reviewers	
Cristina Montiel Molina	Universidad Complutense, Spain
Jean Louis Rossi	Université de Corse Pascal Paoli, France / The European Science and Technology Group (E-STAG)
Internal reviewers	
Alfred de Jager	European Commission, Joint Research Centre
Sara Peláez	University of Limerick, Ireland
Esmeralda Paupério	University of Porto, Portugal
Xavier Romão	University of Porto, Portugal
Rodrigo Rudge Ramos Ribeiro	Getulio Vargas Foundation, Brazil

SCS 5. COVID-19 emergency

Team of authors	
Lead Author	
Montserrat Marin Ferrer	European Commission, Joint Research Centre
Contributing Authors	
Jas Mantero	Independent consultant
Béatrice d'Hombres	European Commission, Joint Research Centre
Elisabetta Vignati	European Commission, Joint Research Centre
Enrico Pisoni	European Commission, Joint Research Centre
Teresa Lettieri	European Commission, Joint Research Centre
Francesca Campolongo	European Commission, Joint Research Centre
Julia Le Blanc	European Commission, Joint Research Centre
Marco Ratto	European Commission, Joint Research Centre
Vanda Almeida	European Commission, Joint Research Centre
Salvador Barrios	European Commission, Joint Research Centre
Michael Christl	European Commission, Joint Research Centre
Silvia De Poli	European Commission, Joint Research Centre
Alberto Tumino	European Commission, Joint Research Centre
Wouter van der Wielen	European Commission, Joint Research Centre
Luca Onorante	European Commission, Joint Research Centre
Valentina Montalto	European Commission, Joint Research Centre
José M. Rueda Cantuche	European Commission, Joint Research Centre

SCS 6. Education, cultural inclusion and disasters

Team of authors	
Lead Author	
Christian Morgner	University of Leicester, UK
Contributing Authors	
Danuta Kaźmierczak	Pedagogical University Krakow, Poland
Kalliopi Sapountzaki	Harokopion University of Athens, Greece
External reviewers	
Erich Striessnig	Wittgenstein Centre for Demography and Global Human Capital, Austria
Dimiter Velev	University of National and World Economy, Bulgaria
Margarita Zango Pascual	Universidad Pablo de Olavide de Sevilla, Spain
Franci Zlatar	Slovene Philanthropy, Slovenia

KJ-03-20-637-EN-N

Publications Office
of the European Union

doi:10.2760/003011

ISBN 978-92-76-23133-2