Chapter 1

Introduction

Online Version

1 Introduction

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1 Introduction

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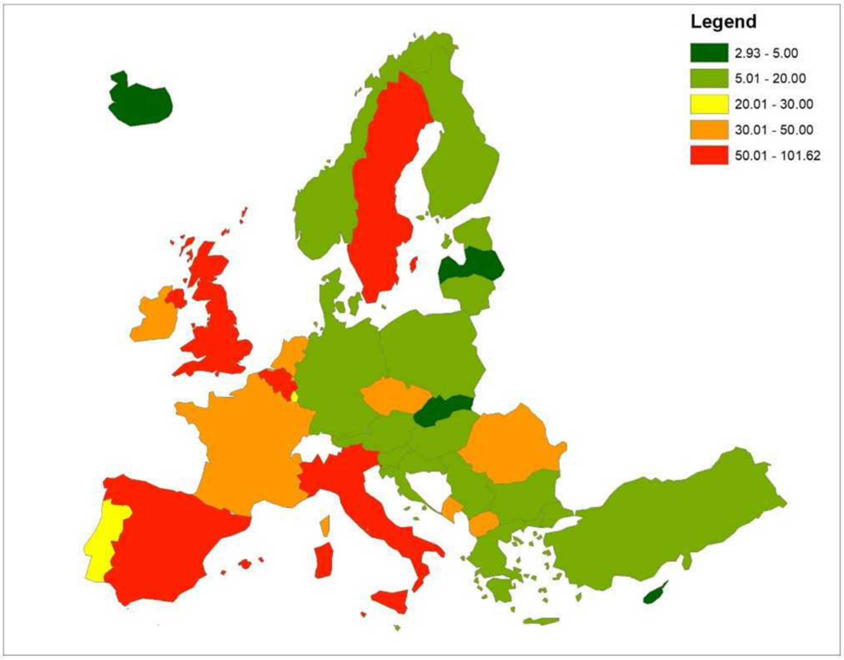
1 Introduction

In a globalised world, we experience the impacts of events happening far from our communities. The coronavirus disease 2019 (COVID-19) emergency that we are living through shows us what systemic risk means in practice. Whereas in January and February 2020 most cases of COVID-19 were reported in China, Europe became the centre of the pandemic in March, and it spread through other parts of the world in the following months.

The pandemic has disrupted our daily lives and affects several socioeconomic and cultural aspects of our societies. In early November 2020, the number of cases globally is over 48 million, with more than one million deaths (ECDC, 2020a). In Europe, the number of deaths is over 25 000 in various countries, although the rates are highly variable (Figure 1).

Figure 1. *Number of deaths reported by countries on the 1st November 2020 per 100.000 inhabitants.*
Source: *Authors, based on data from ECML-COVID (European Commission, 2020a) and the Eurostat, 2019.*
Note: *the countries selected are part of the Union Civil Protection Mechanism (UCPM).*



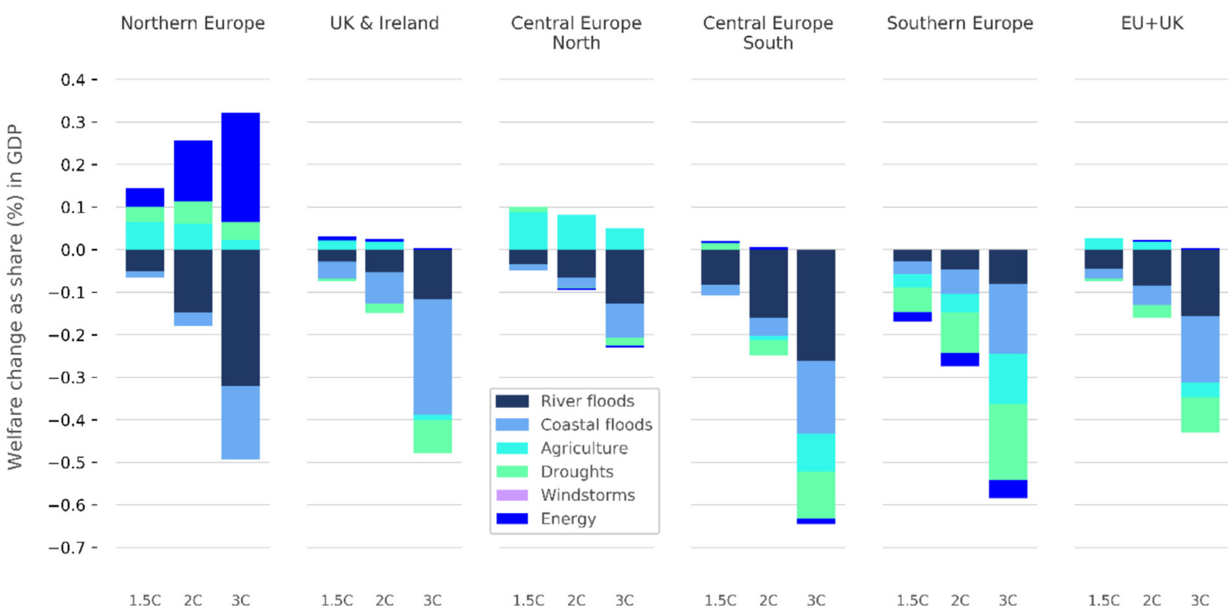
A deep recession is expected in the EU in the years to come. The EU's gross domestic product (GDP) contracted by 3.3 % in the first months of 2020 and by 11.9 % in the second quarter of the year, showing the effects of the containment measures taken by Member States because of the pandemic, with sharp reductions in employment (Eurostat, 2020a). The second wave of infections in autumn would hinder a fast economic recovery.

The industrial sector contracted by more than 18 % between February and May 2020 (Eurostat, 2020b) and the loss in the service sector has been around 22 %, with the downturn particularly affecting hotels and restaurants. In early June 2020, the automotive sector, one of the sectors most affected by the lockdown measures, declared having produced 2 million vehicles fewer than expected in the EU-27 and the United Kingdom during the crisis; the average shutdown duration in the EU-27 and the United Kingdom was 30 days (ACEA, 2020). A full overview of the first estimates of the economic impacts of COVID-19 in the EU can be found in the Commission staff working document 'Identifying Europe's recovery needs' (European Commission, 2020b).

We already knew that risks do not respect borders. The floods of 2005, 2010 and 2016, which affected several countries in central and eastern Europe; the fire in an agrochemical storehouse in Sandoz, Switzerland, that contaminated the surrounding area and affected the water and fauna of the Rhine River kilometres away; the floods in Thailand in 2011 that disrupted the production lines of Toyota in countries such as Canada, Malaysia and Vietnam (Toyota, 2011) – all these provided evidence of this fact. Both direct and indirect impacts can be suffered far away in time and space. It is no longer necessary to emphasise that the level of globalisation we have reached means that everything is connected to everything else. Besides cascading effects, disasters happening in a relatively short time span can result in greater losses than the sum of the independent events. A second lockdown was imposed on account of the sharp rise in COVID-19 cases in Lebanon after the explosions in the port of Beirut in August 2020 (Aljazeera, 2020). The event increased the vulnerability of Beirut's inhabitants, as more than 300 000 people were left homeless and around half of the city's health facilities were reported to be non-functional (BBC, 2020).

Mass displacement is indirectly related to disasters, albeit not straightforwardly (Berlemann and Steinhardt, 2017). Disasters, together with conflict, violence, environmental degradation and other underlying drivers, seem to push people to look for new opportunities far from home (Naude, 2008; Drabo and Mbaye, 2011; IOM, 2019).

Figure 2. *Welfare loss (% of GDP) from climate impacts considered for three warming levels for the EU and the United Kingdom, and for macro-regions. The results represent the change in welfare if warming levels act upon the current economy, compared with the current economy in the present climate..* ***Source****: Feyen et al., 2020.*



Anomalies in temperature and precipitation are related to individuals migrating to richer countries (Backhaus et al., 2015; Coniglio and Pesce, 2015); human mobility can form part of a strategy for adapting to climatic changes. In the European context, the study Peseta IV (Feyen et al, 2020) evaluated the benefits of reducing greenhouse gas emissions and potential adaptation measures for some sectors in response to extreme events such as floods, forest fires and droughts (Figure 2). It concluded that taking no mitigation or adaptation measures would have significant consequences for our welfare.

The characteristics of the assets exposed to risk play a vital role in explaining why some groups of individuals or sectors are more affected than others one a hazard materializes. Socioeconomic, cultural and physical factors have an influence on the consequences of an event. Older age, which is related to issues of mobility, communication and chronic diseases, increases the susceptibility of people to disasters. Figures from recent disasters support this concept: of the nearly 1 000 people who died in Louisiana as a result of Hurricane Katrina in 2008, almost half were 75 or older (NBC, 2008), and the average age of victims of the wildfires in 2017 and 2018 in California was over 70 (Los Angeles Times, 2017, 2018). Europe has one of the highest numbers of old people in the world, and the population continues to grow older: by 2070 there are expected to be 20 % more people in Europe aged 65 or older compared with the number today (UN, 2019; European Commission, 2020c). This is another example of vulnerability. Besides the vulnerability dimension of the assets exposed, the nature of the hazard and the decisions taken post event explain the long-term consequences (Noy and du Pont IV, 2016).

Culture shapes our understanding of the significance and role of disasters, influencing how we perceive risk (Alexander, 2012). Other factors, such as past experiences and trust in authorities and scientific advisory groups, have an effect on risk perception and how people prepare for risk (Wachinger et al, 2013). Loewenstein et al. (2001) point out that emotional reactions play a significant role in the moment of decision-making. The differences in response between countries and regions in the first weeks of the COVID-19 emergency are an example of this: different restrictions to ensure social distancing were applied in Europe at different times from February 2020, even within certain countries (ECDC, 2020b). Governments made decisions in the middle of the crisis, with limited knowledge and few data available to analyse, which resulted in a sense of a lack of coordination and distrust of citizens (Krastev and Leonard, 2020). Misinformation also fuelled rumours, conspiracy theories and stigma around the world (Islam et al., 2020). It became obvious that we are still striving to find the right process to inject science into policy in a timely manner.

Data are essential in developing efficient responses to many of the crises that the EU is currently facing. Through data, policymakers are able to understand which measures to take and projects to fund to enhance the social and economic recovery, but the benefit of data goes beyond this. Databases of historical events and their related effects allow us to track the events and the loss trends over time, to assess the measures implemented before the event to prevent it or mitigate its effects and to study the roots of disasters. Identifying and analysing the causes and drivers of hazards, exposure and vulnerability, and the capacities of people and assets, would allow us to better predict future events and more effectively plan measures to reduce risk, which will enhance resilience. The collection and sharing of data after a disaster should be reinforced to enable actions to be taken to prevent hazards materialising.

Unity and solidarity have been key in the EU in the face of the COVID-19 pandemic, showing that our interdependencies require us to work together, more than ever, to be stronger. Amid the difficult times in which we are living, we should take advantage of the post-disaster period to increase our resilience, by working towards a greener, more digital and inclusive society. The response to and recovery from the pandemic are of course a priority, but should not distract us from reaching imperative societal goals. Learning from our past experiences and investing in research and innovation will help us to better direct our efforts. Could this crisis become an opportunity to launch a reinforced evidence-based and coordinated risk management governance?

2 Towards a more preventive approach

The Union Civil Protection Mechanism (UCPM) and the Sendai framework have pushed the disaster risk management (DRM) community to anticipate losses and damages before these materialise

The cooperative effort to manage disaster risk at EU level began in 2001 with the aim of improving the response of EU countries to disasters (EU, 2001). Taking into account the increasing costs of disaster losses, the Union Civil Protection Mechanism (UCPM) (EU, 2013) went beyond response towards a more preventive approach to disaster risk. This mechanism aims to provide a better understanding of the risk landscape and the potential capacities and to ensure a quick mobilisation of these before and during an event. The UCPM has allowed the exchange of experts and lessons learned and the realisation of exercises. It has received more than 100 requests for internal assistance and monitored hundreds of events, inside and outside the EU (Directorate-General for European Civil Protection and Humanitarian Aid Operations, 2018). In 2019, the mechanism was reinforced to increase the EU's overall capacity to directly confront events (Decision (EU) 2019/420; EU, 2019a) and, as a result of the COVID-19 emergency, the European Commission has proposed further enhancements (see Section 4 below).

Risk anticipation and management are fundamental to the major closely related international agreements and frameworks that have been in place since 2015 – the Sendai framework, Agenda 2030, the Paris Agreement and the 2016 Urban Agenda. Notably, in adopting the Sendai framework the international community agreed a fundamental shift in the approach to disaster risk reduction, moving from managing disasters to a proactive and systemic risk management approach, promoting the mainstreaming of DRM in countries' sustainable development and poverty reduction approaches, and the building of resilience in and by communities.

Furthermore, the Sendai framework focuses on the importance of building a solid data and evidence base, investing in risk reduction and strengthening disaster risk governance, as well as continuing to strengthen preparedness. In addition, the Sendai framework expanded the original Hyogo framework remit of DRM beyond natural hazards to include 'man-made hazards, as well as related environmental, technological and biological hazards and risks' (UNDRR, 2015, p.5). To monitor the progress of countries in achieving this goal, seven targets were set on the impacts of disasters on populations, critical infrastructures and livelihoods.

These international frameworks have also presented significant opportunities to build coherence across different policy areas. For example, there is clear recognition of the links between the Sendai framework and the Agenda 2030 Sustainable Development Goals in terms of reporting, monitoring and thematic overlap. In addition, there are clear synergies between the science and technology objectives of the Sendai framework and the Paris agreement through national and regional projects and improved coordination of existing networks and scientific research institutions.

There is no doubt that local action is needed to implement global international frameworks and agreements that are relevant for DRM, and more broadly to achieve sustainable development. Cities and municipalities are the testing ground for innovative solutions on how to prepare for, deal with and recover from disasters. Local action can bring significant and immediate benefits, harness local public opinion and facilitate cooperation across sectors. This facilitates an integrated approach to the implementation of global frameworks for disaster risk reduction, climate change and sustainable development.

3 Science for policy planning and implementation

Science plays an important role in societal debates and allows policies to be based on the most up-to-date knowledge. Science can help policymakers visualise the complexity of the problems at hand, better define the issues and put alternative policies on the table.

The push for a more preventive approach to anticipate risk requires collaboration between different disciplines, but also stakeholders engaged in different sectors. Science for disaster risk management 2017 (Poljansek et al., 2017) highlighted the need to reinforce transdisciplinarity to work across sectors and levels to manage risk. This type of approach helps to create knowledge for complex problems through the collaboration, and the integration of knowledge, of different stakeholders and disciplines, which leads to approaches and solutions that are easier to implement in practice (Gall et al., 2015; Ismail-Zahed et al., 2017). Despite the differences between and challenges facing the science–policy interface for disaster risk reduction in the EU (Albris and Cedervall Lauta, 2020), solid alliances and research strategies have been created in the last few years to reinforce collaboration between these actors. The European Commission used the Sendai framework as an opportunity to develop a disaster risk-informed approach for all policies (European Commission, 2016), engaging the research community to address the gaps in knowledge through different frameworks, such as the EU research and innovation programme Horizon 2020. At the same time, significant progress has been made under the joint coordination by the policy departments of European Commission (Directorate-Generals (DGs)), establishing close ties between projects under Horizon 2020 and their potential users (such as DG HOME through the Community of Users on Secure, Safe and Resilient Societies ([1])).

The forthcoming Horizon Europe research initiative (2021–2027) will be implemented by the Commissioner for Innovation, Research, Culture, Education and Youth, together with Member States, the research community and civil society. With the aim of delivering solutions to the greatest challenges the world is facing, the programme will be structured in missions, grouped into different areas. One of these areas, 'Adaptation to climate change, including societal transformation', will support citizens to connect with science and policymakers in the process of climate change adaptation. Lastly, it will reinforce the culture of evidence-based policymaking and create and make full use of the knowledge, information and research within the Commission in the development of policies.

3.1 Assessing potential consequences

Disaster risk management needs to be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment – Sendai framework for disaster risk reduction 2015–2030.

([1]) *https://www.securityresearch-cou.eu/home*

The foundation for effective DRM is to first identify and assess the risk of a natural or man-made hazard; hence, understanding of risk is the first Sendai priority (UNDRR, 2015). By quantifying disaster risk and communicating the potential impacts, governments, communities and individuals can make informed decisions to manage their risk.

Disaster risk assessments enable decision makers to obtain quantitative information to understand the potential impacts and risks of natural hazards. The fundamental elements of risk – hazard, exposure and vulnerability – are integrated through modelling to determine the likely deaths, damages and losses that will result from a hazard event, before the disaster strikes. The scientific community should be engaged in the risk assessment exercise, and particularly in the analysis of risk, its interpretation and communication, and the design of recommendations for action (see section 3.2).

The ability to model disaster loss is a powerful tool for DRM. Risk assessments can serve multiple purposes depending on the stakeholder – these can range from undertaking urban risk assessments for disaster preparedness, to multi-country financial risk assessments to support the design of financial transfer mechanisms. They can also be used to understand the cost–benefit ratios of investing in measures to reduce risk. Risk assessments are also increasingly used to calculate risk under current and future climate and socioeconomic scenarios, providing decision makers with an additional impetus to act immediately on the underlying drivers of risk.

In recent years, the numbers of national-, regional- and city-level risk assessments have rapidly increased, with

BOX 1 a)

Anticipating risks at the local level

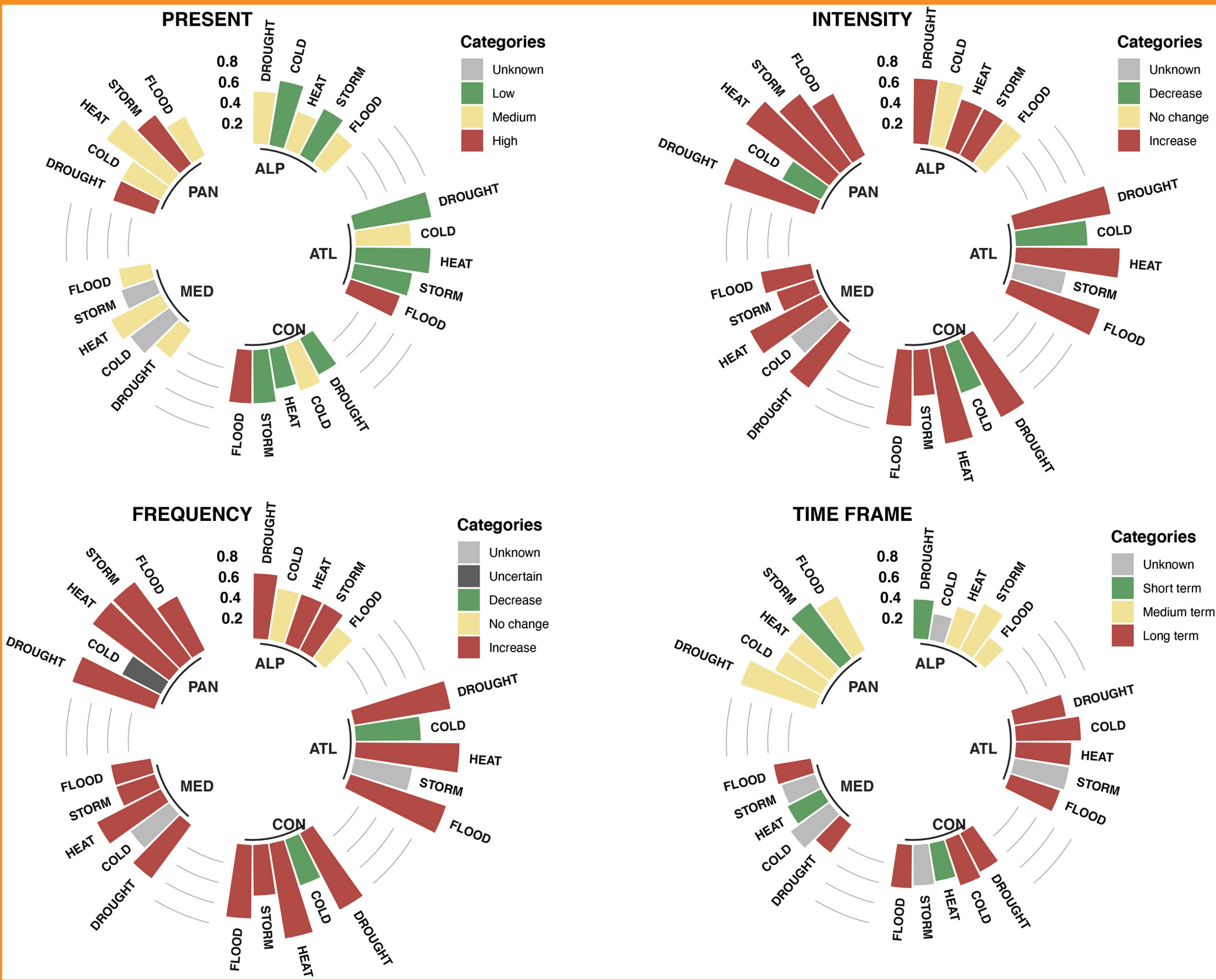
Several cities and regions already make extensive use of short- and long-term projections for adaptive strategies. For instance, the Austrian Environment Agency uses the Copernicus Services to measure surface imperviousness for the whole country, enabling local discussions on flood risks (Copernicus, 2019). Early warning systems for heatwaves are in place in several cities and regions of Europe, bringing together information on weather projections, health services and the vulnerability of the population to better target health service interventions (see, for instance, Lowe et al., 2011).

Under the Covenant of Mayors for Climate and Energy, local authorities combine DRM with climate risk assessment and vulnerability and adaptation measures, thus integrating future climate change-related disasters into planning. By September 2020, almost 2 800 cities in the EU had committed to develop local climate adaptation strategies (Covenant of Mayors for Climate and Energy, 2020). From the risk and vulnerability assessments developed by the signatories, many hazards have been identified (Figure 3), many of which are expected to increase in frequency.

BOX 1 b)

Anticipating risks at the local level

Figure 3. *Current hazard level, expected changes in future intensity, frequency, and time frame reported by the municipalities of the Covenant community.* ***Source****: Hernandez et al., 2020*



city-scale risk assessments driving short- and long-term city resilience planning (Box 1 a,b) and national risk assessments providing access to investment funds for risk reduction, such as in EU Member States. Sector-level risk assessments are also increasingly common in the transport, education, agriculture, health and water sectors – evidence that disaster risk reduction is increasingly moving into the mainstream.

Risk identification provides the basis for any assessment and therefore all DRM actions: whether to reduce risk by putting policies and plans in place that will help avoid the creation of new risk or by addressing existing risk either physically or financially, or to inform improved resilient reconstruction design. Emergent risks are typically obvious in retrospect – they are the result of a series of events that cross human-imposed boundaries, whether institutional, geographic, disciplinary, conceptual or administrative. Scientists should support the stage of risk identification, using data from previous events studied, from foresight exercises, from hazard monitoring and from research in general, to frame the problem at hand.

In some cases risks are not actually new, but are emerging systemic risks that require new methods of assessment, management and governance. To fully understand systemic risks, it is necessary to understand the gap between global, regional and local risks and integrate risk perception and prevention and mitigation strategies to evaluate the potential impacts of financial market regulations and possible innovative financial tools on several sectors such as food security and the environment.

3.2 Tackling the risk drivers

Addressing disaster risk delivers both immediate and longer term development gains. While investing in disaster resilience often requires higher start-up costs, it is cost-effective in the long term. Studies have indicated that investing in preventive measures pays off: a report from the US National Institute of Building Sciences found that, for every dollar spent on grants aimed at improving disaster resilience, society saves six dollars (Multihazard Mitigation Council, 2017).

Since we cannot prevent some hazards from occurring, the main opportunity for reducing risk lies in tackling vulnerability and exposure (Box 2). Reducing these two components of risk requires the underlying drivers of risk to be identified and reduced. These are particularly related to poor economic and urban development choices and practices, degradation of the environment, poverty and inequality and climate change. Addressing these underlying risk drivers will reduce the consequences of disaster impacts and, consequently, maintain the sustainability of development.

The Intergovernmental Panel on Climate Change (IPCC) had already recognised in 2012 that climate change poses new challenges to disaster managers (Lavell et al., 2012) (Box 3). Both the disaster risk reduction and the climate change adaptation communities have made efforts to integrate their work to exploit synergies and avoid any overlaps in meeting the common objectives of decreasing vulnerabilities and enhancing resilience. Hemmers et al. (2020) stressed the need to work together on data collection and risk assessment methodologies as areas of common interest.

BOX 2

Examples of holistic solutions

Land use planning

Between 1970 and 2010, the total urban surface area exposed to flooding more than doubled, from 18 000 km2 to 44 000 km2 (Jongman et al., 2012). At least 1 000 million urban dwellers are highly exposed to flood risk in the world (Ehrlich et al., 2018; Gu, 2019). The expansion of impermeable surfaces decreases infiltration and increases run-off during precipitation events. Deforestation also contributes to increased surface run-off not only by reducing the amount of moisture that trees absorb from the soil but also by removing the tree canopy; without the canopy, more rainwater reaches the ground, and reaches it more quickly. Poor planning at city level can create a vicious cycle, exacerbating risks and exposure. For instance, the covering of soil for housing and roads increases the absorption of energy from the sun and leads to higher urban temperatures, which is also known as the 'urban heat island effect'.

Land-use-planning policies that incorporate risk are important for controlling increases in disaster risk, primarily by providing a mechanism to prevent new development or detrimental changes of use in hazard-prone areas. For example, land-use-planning policies can help to ensure that vulnerable or high-value assets and heavily occupied buildings (business and residential) are not located on hazard-prone land and can seek to reduce risk exposure by placing low-density-usage activities (agriculture, parks and recreational land) in those areas.

Nature-based solutions

With more extreme weather events, and increasing development along rivers and coastlines, impacts from climate-related disasters are on the rise. Governments are turning to nature to help manage these disasters. Nature-based solutions can conserve or restore nature, while supporting conventionally built infrastructure systems, or 'grey infrastructure'.

The use of green infrastructure such as forests, parks, wetlands, green walls and green roofs has been effective in reducing the risk of disasters at local level. Such approaches also lead to significant co-benefits such as better air quality and enhanced quality of life, as well as opportunities for employment (Pridmore et al., 2017; McVittie et al., 2018).

In 2016, Bratislava, Slovakia, implemented measures to enhance the urban resilience of the city, planting trees and establishing green roofs and rainwater retention facilities to mitigate the impact of intense rainfall and heat. Similarly, the city of Malmö, Sweden, has integrated green infrastructure and storm water management measures as part of its Western Harbour development (Climate-ADAPT, 2020).

BOX 3

Building resilient infrastructures

According to Hallegatte (2009), one problem in adapting to climate change is the rate at which conditions are changing: infrastructure and investments being implemented now must be robust enough to cope with a wider range of climate conditions in the future. This need incurs additional costs for designing that infrastructure. Hallegatte (2009) cites five methods to promote effective adaptation in an uncertain future climate:

- ‘No-regret’ strategies, which provide benefits regardless of whether the disaster risk evolves because of a changing climate. These strategies include improved building insulation to provide immediate energy-saving benefits, and land use planning to reduce losses under current and future climate conditions.

- Reversible and flexible options. These options can be halted or adjusted at short notice, with little or no sunk cost. They include climate-proofing new buildings and erecting flood defences that can easily be made higher and stronger at little cost.

- Safety margins in investments. The design of infrastructure systems and structures should account for worst-case scenarios, rather than relying on later modifications. For example, drainage systems should be designed with sufficient capacity to cope with anticipated run-off.

- Appropriate adaptation strategies. These include ‘soft’ adaptation strategies, such as early warning systems, evacuation plans and insurance schemes, and long-term planning horizons with shorter term revisions of plans.

- Shorter lifetime of investments. This approach reduces the uncertainty about climate change in decision-making. Cost–benefit assessment of investments should account for future losses and costs as well as current costs; this approach is particularly important for long-term investments.

A new framework for understanding infrastructure resilience was recently proposed, highlighting the ability of infrastructure systems to function and meet the needs of populations during and after natural hazards (Hallegatte et al., 2019).

Climate change projections call for action and scientific groups are already working to encourage the adaption of European standards to a changing climate. Athanasopoulou et al. (2020) have prepared the basis for further work on the thermal design of structures and Sousa et al. (2020) presented the expected implications of corrosion due to climate change.

3.3 Information technology

In recent years, data-driven approaches have emerged in response to disasters through the smart use of data. One of the targets established to monitor the progress of the Sendai framework calls for multi-hazard early warning systems and risk information to be made available and accessible in the future. Warnings are issued based on predictions, that is, on the systematic monitoring of precursors of hazards, which are analysed together with the assets exposed and the vulnerability and capacities of the system. This constant assessment of potential events requires sound scientific knowledge.

The scientific community has made huge progress in improving warning systems by adopting the most advanced combination of technologies (including artificial intelligence and space data) to capture any kind of anomalous signal and reactively analysing such signals using a combination of technologies and expert advice, such as the Epidemic Intelligence from Open Sources (EIOS) ([2]), the Global Disaster Alert and Coordination System (GDACS) ([3]), the European Forest Fire Information System (EFFIS) ([4]), the European Flood Awareness System (EFAS) ([5]), the European Drought Observatory (EDO) ([6]) and the future European observatory of Climate Change and Health. In the last few years, social media has been revealed as a useful tool to collect and analyse data, both before and during an emergency, and for issuing a response (Box 4). Bee and Budimir (2019) outline some examples of tools that exploit the opportunities provided by social media.

BOX 4.

Projects exploiting social media data: FIUME and SMDRM

FIUME (Flood risk and Impact in Urban areas using social Media) is an exploratory research activity focused on identifying the impacts of floods in urban areas on populations, infrastructures and services by building hyper-local geocoders and a machine learning model.

FIUME will be integrated in the medium term in SMDRM (social media for disaster risk management), which aims to use social media to improve situational awareness during any kind of disaster, and especially to fill the gap during the first hours of response before satellite maps are available. The SMDRM project has several work packages, which were developed at the Joint Research Centre (JRC) together with external collaborators:

- a multilingual machine learning classifier for identifying relevant text;
- a machine learning image classifier for detecting the impacts of a disaster;
- a geocoder at the global scale for aggregating the information extracted;
- a filter for selecting the most relevant information and presenting it to crisis managers.

The system packages for flood classification will be released into the Global Flood Awareness System (GloFAS) (Lorini et al., 2019).

([2]) *https://www.who.int/eios*
([3]) *http://dev.gdacs.org/*
([4]) *https://effis.jrc.ec.europa.eu/*
([4]) *https://www.efas.eu/*
([5]) *edo.jrc.ec.europa.eu*

4 Building a more resilient EU post COVID-19 – challenges for disaster risk management

'In the next five years, we have to work together to allay fears and create opportunities' – Ursula von der Leyen.

In July 2020, the European Council agreed an ambitious COVID-19 recovery plan, also known as 'Next Generation EU'. The plan, with a total budget of EUR 750 billion, was agreed alongside the EU's Multiannual financial framework (MFF) for 2021–2027; together they will contribute to the implementation of the new European Green Deal presented in December 2019 (European Commission, 2019). These key policies are mutually reinforcing and are based on sound science and strengthened risk management principles, bringing new challenges and increased demands for research in DRM. Overall, all EU policies are placing increased emphasis on the integration of climate and disaster risks in policy actions and operations, including by earmarking 30 % of the funding in the MFF and Next Generation EU for climate change.

Both the Next generation EU and the European Green Deal have been widely documented ([7]) ([8]); in this section the key elements of DRM are presented, including suggestions for research and data priorities.

4.1 Next generation EU

RescEU will be enhanced so that Europe is able to act more quickly and be more flexible once a serious cross-border threat, such as COVID-19, emerges.

The recovery plan addresses economic and social investment in the Member States and also includes the enhancement of crisis and health preparedness and response at the EU level. The reforms and investments will help the EU to recover by allowing Member States to move towards a greener, more digital and socially resilient future.

Among the lessons learnt from the COVID-19 crisis has been the need for enhanced coordination and an improved crisis preparedness response at the European level to help address future scenarios. To improve crisis preparedness and management, the Commission will reinforce the European Medicines Agency and give a stronger role to the European Centre for Disease Control (ECDC) in coordinating medical responses in crises. The Commission has also proposed a standalone EU4Health programme to support Member States and the EU to build capacity and preparedness for future health crises. It will help deliver a long-term vision for well-performing and resilient public health systems, notably by investing in disease prevention and surveillance, and improving access to healthcare, diagnosis and treatment.

In addition, the Commission has proposed strengthening rescEU to build permanent capacity to handle all types of emergencies. This will enhance its capacity to invest in emergency response infrastructure, transport capacity and emergency support teams. It will create EU-level reserves of essential supplies and equipment to be mobilised in response to major emergencies.

([7]) See *https://ec.europa.eu/info/live-work-travel-eu/health/coronavirus-response/recovery-plan-europe_en*
([8]) See *https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en*

In addition, European standards provide a means to roll out security technologies. European standardisation organisations can contribute to overcoming fragmentation in this field by increasing the interoperability and compatibility of systems and products related to security, crisis management, risk, resilience and business continuity. Another lesson is the need for a fast, flexible and coordinated EU response to crises. In this regard, the Commission is proposing to strengthen its emergency tools and make them more flexible so that resources can be deployed quickly and at scale when needed. This includes the European Solidarity Fund and the European Globalisation Adjustment Fund. The Solidarity and Emergency Aid Reserve will also be significantly strengthened to enable a rapid response to crises both within and outside the EU.

Furthermore, with the aim of strengthening civil protection, the Commission has proposed reinforcing a cross-sectoral and societal preparedness and preventative approach to transboundary DRM, including establishing a baseline and planning elements at the European level, taking into account how climate change affects disaster risk.

As part of the Next Generation EU investment and recovery plan, the European Commission has announced recently the “New European Bauhaus”. It would be a space of co-creation where architects, engineers, artists and designers would work to transform the EU to reach its environmental, economic and culture goals. The initiative aims primarly to bring the European Green Deal to life by rethinking the way we relate with environment and to tackle climate change (European Commission, 2020e).

4.2 The European Green Deal – key elements for disaster risk management

COVID-19 recovery actions are an opportunity to deal with the root causes of the disaster and to accelerate our transition towards a more sustainable society.

The Commission will adopt a new, more ambitious EU strategy on adaptation to climate change. This is essential, as climate change will continue to create significant stress in Europe in spite of the mitigation efforts. Strengthening the efforts on climate-proofing, resilience building, prevention and preparedness is crucial. Work on climate adaptation should continue to influence public and private investments, including in nature-based solutions. It will be important to ensure that, across the EU, investors, insurers, businesses, cities and citizens are able to access data and develop instruments to integrate climate change into their risk management practices.

The Sustainable Europe Investment Plan is the investment pillar of the European Green Deal and will mobilise through the EU budget and the associated instruments at least EUR 1 trillion of private and public sustainable investments over the coming decade. It will form an integrated European approach to reinforce risk management, recognising the importance of green investments in any recovery strategy to be applied to the pandemic.In late 2019, before the COVID-19 pandemic, more than 75 % of European citizens felt that climate change is a serious problem in the EU and 98 % believed that it has a direct effect on their personal life ([9]). In the middle of the COVID-19 crisis, EU citizens still believe that part of the budget should be dedicated to climate change and environmental protection, together with public health and economic recovery (European Parliament, 2020).

Accessible and interoperable data are crucial to the Green Deal. Data, combined with digital infrastructure (e.g. supercomputers, the cloud, ultra-fast networks) and artificial intelligence solutions, facilitate evidence-based decisions and expand the capacity to understand and tackle risk management challenges.

([9]) https://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/survey/getSurveydetail/instruments/special/surveyky/2257

A specific urgent priority is to boost the EU's ability to predict and manage environmental disasters, bringing together European scientific and industrial excellence to develop a very high-precision digital model of the Earth. Biodiversity is one of the pillars of the Green Deal. The EU Biodiversity strategy 2030 (European Commission, 2020e) aims to ensure that ecosystems function for our health and security, indicating that they protect us from disasters and other drivers of risk. The Commission is currently preparing an impact assessment setting out options for EU nature restoration targets in 2021 (including making them legally binding) to restore degraded ecosystems, in particular those with the most potential to capture and store carbon and to prevent and reduce the impact of disasters.

Linking biodiversity, resilience and sustainable economic recovery, a new EU Forest strategy will also be put forward by the Commission in early 2021, as part of the Green Deal. Likewise, the Strategy Farm to Fork (European Commission, 2020f) has been drafted to ensure food security in face of several recurring threats, such as biodiversity loss, forest fires, pests and droughts.

Investing in research, innovation and knowledge exchange will be key to gathering the best data and developing the best nature-based solutions. Research and innovation can test and develop how to prioritise 'green' over 'grey' solutions and help the EU to support investments in nature-based solutions, such as in old industrialised, low-income and disaster-hit areas (European Commission, 2020e).

EU space policy aims to tackle some of the most pressing challenges today, including fighting climate change and disasters. Under Copernicus, the EU's Earth observation programme, immediate information has been provided when disasters strike, such as earthquakes, forest fires or floods, enabling better coordination between emergency and rescue teams. In addition, the satellites supporting this observation system help countries to assess the risks of such disasters. The EU has two other flagship space programmes: Galileo, Europe's global satellite navigation system, and EGNOS, the European Geostationary Navigation Overlay Service. These provide 'safety of life' navigation services to aviation, maritime and land-based users over most of Europe. Under the new Green Deal, additional resources for the three services are planned, as well as reinforcement of their efforts to address climate risks and crisis management.

4.3 Digitalisation and inclusiveness

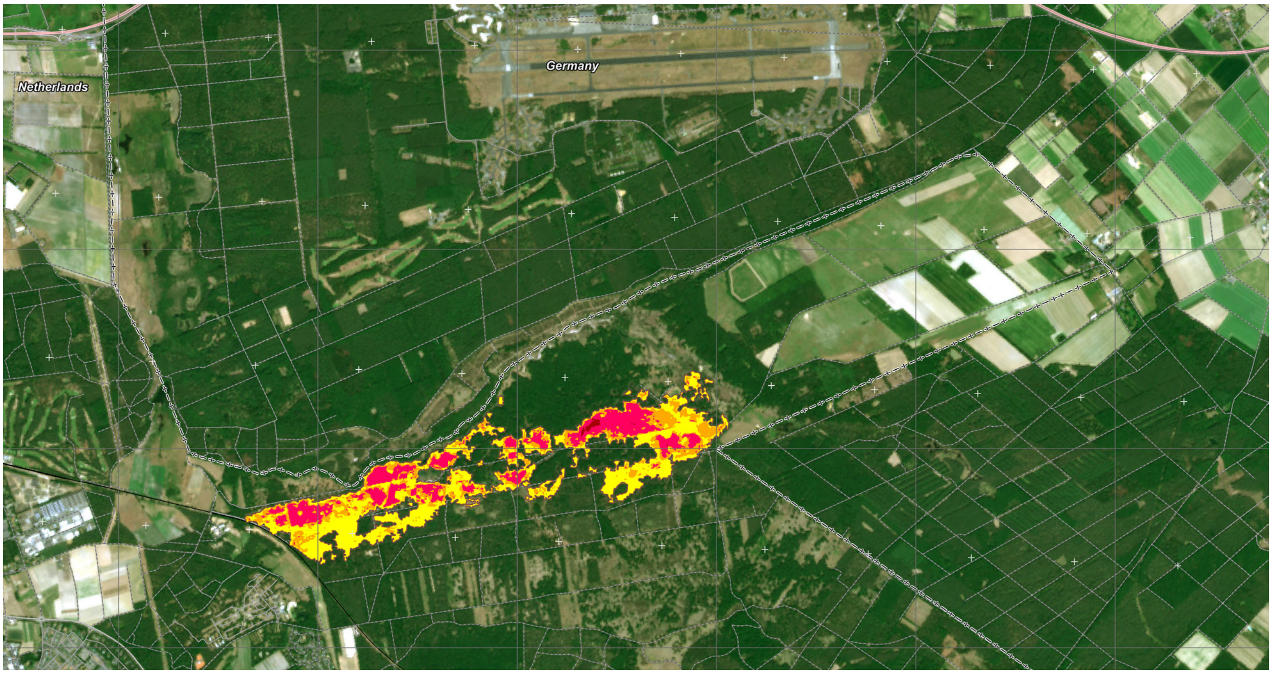
Closing borders and spaces to mitigate the spread of COVID-19 put technology at the centre of our lives, ensuring business continuity and access to services and facilitating people's interactions in general. The added value of digitalisation and data analytics in DRM is vast: data from satellite imagery and sensors can be used for developing vulnerability maps to plan how to prevent certain hazards or to predict damages; it is necessary to count with data and assess the capacities in place to monitor risks, as part of early warning systems; and machine learning can help to classify information from social media for use while responding to an event. Digitalisation allows DRM to optimise processes and to obtain new results. In remote situations or when the reality does not allow face-to-face meeting, information and communication technology infrastructure provides an opportunity for raising awareness and capacity building, such as through the use of training and courses.

The Copernicus Emergency Management Service (EMS) on-demand mapping provides geospatial information on the request of EU Member States to support emergency activities. The service has been activated more than 400 times since 2012, analysing the immediate damages from floods, forest fires, cyclones and industrial accidents, among others([10]).

([10]) https://emergency.copernicus.eu/mapping/list-of-activations-rapid

Likewise, Copernicus can provide geospatial information in support of disaster management activities not related to the immediate response, such as information on damage assessment after the earthquake that hit Zagreb in March 2020 or after the wildfire in Meinweg National Park (the Netherlands) in May of the same year. The analysis of the vegetation before and after the events served to determine the burned area in Meinweg National Park, which was almost 150 ha (Figure 4).

Figure 4. *Overview map of the damage assessment analyses of the affected area in Meinweg National Park.*
Source*: e-GEOS, SIRS, 2020. © European Union, 2020.*
Note*: Yellow, negligible damage; orange, moderate damage; red, high level of damage; dark red, destroyed area.*



Both the infrastructure and regulations should be in place to keep the EU safe and active. Following the EU Cybersecurity Act (Regulation (EU) 2019/881; EU, 2019b) and the Directive (EU) 2019/1024 on open data and the re-use of public sector information (EU, 2019c), a set of actions has been planned to enable data and artificial intelligence to drive the future of the EU.

Security threats related to information and communication technologies will probably increase over the next few years. Social media and media platforms can provide a window to access information to facilitate social interactions, strengthening transparency and accountability and social innovations. In contrast, disinformation in times of disasters is particularly dangerous. For example, during Hurricane Irma in 2017, fake news circulated in the United States before and after the event. The US National Weather Service publicly denied one fake weather forecast but the information had already been shared on social media more than 36 000 times (Concha, 2017).

Digitalisation supports the implementation of other European Commission priorities, facilitating citizens to fulfil their rights and boosting the EU market. During the first weeks of the pandemic, the number of countries providing information related to the emergency through their portals, apps or social media increased considerably (United Nations, 2020). Furthermore, digitalisation directly benefits some groups of society, such as people with disabilities, with regard to entering the labour market (Kilhoffer et al., 2019).

New technologies create a space for citizens to participate in research, opening channels for new audiences and citizens in general to contribute in research, by collecting, analysing and visualising data, although it is important to consider affordability and access (Mazumdar et al., 2018).

The COVID-19 emergency has also made evident the differences in digitalisation between and within countries. While 79 % of people in Denmark participated in social media in 2017, this share was below 50 % in France, Italy and Slovenia (Eurostat, 2019). Similarly, the use of social media drops considerably among people aged over 65 (Khoros, n.d). In addition, in spite of having access to internet, low broadband speeds and high costs have a direct effect on small and medium-sized enterprises and low-income families. Finally, before the pandemic crisis, 23 % of EU citizens had a low level of digital skills and 21.4 % had no digital skills at all (Dewar et al., 2017).

Disaster risk reduction must consider the diversity in needs and capacities of different social groups and minorities (related to age, gender, origin, sexual orientation, educational level, etc.), both before and after an event. Vulnerable groups that tend to be left outside the decision-making process suffer the most once a disaster strikes. Transgender people experience difficulties when registering for shelter and using facilities after a disaster as gender binary norms are assumed (Dominey-Howes et al., 2018).

At the same time, efforts should be made to ensure that digitalisation is ready for the ambitious green goals, supports the common European Health Data Space and supports the new requirements posed by the COVID-19 pandemic, such as telework and e-learning.

5 The Science for Disaster Risk Management 2020 report

The data and information collected after a disaster should be exploited, not only to guide recovery, but also to reinforce the prevention and mitigation of future events.

As shown in the previous sections, we are working to break down silos and encourage collaboration among governance levels and stakeholders to reach a comprehensive understanding of risk, which will help us to reduce disaster risk in a more effective way. The report *Science for Disaster Risk Management 2020: acting today, protecting tomorrow* follows that idea and aims to provide evidence for use by society. As evidence can come from a varied set of actors, the report has engaged experts from academia and research institutions and gathered experiences of civil protection organisations, international organisations, national institutions and civil society organisations in that task. The outcome of the collective effort of more than 300 experts, from different background and disciplines, ensures that the report is comprehensive and relevant, as well as being robust and up-to-date.

As with the previous report, *Science for Disaster Risk Management 2017: Knowing more, losing less*, the current report aims to increase knowledge on disaster risk in Europe by collecting and merging the scientific results from and experiences of several actors. In this report, disaster risk is studied through the analysis of the consequences of an event on various assets of interest: population, economic sector, critical infrastructures, environment and cultural heritage. Chapter 3 is fully dedicated to these assets. Focusing on the impacts, we aim to link different sectors and cover different types of hazardous events, including disasters of natural, technological and malicious origin. We believe that the asset approach followed allows us to have a more systemic view of risk, and to pay attention to vulnerability, one of the risk factors that could be better tackled at the asset level.

A good analysis of impacts, in time and space, is an interesting source of knowledge to exploit to reduce disaster risk. Our resilience depends on our ability to anticipate events and to recover from them. By studying the consequences of a disaster, it is possible to test the actions put in place before it, while it can also be an opportunity to develop the methods and tools used in the risk assessment. At the same time, an assessment of the impacts post event facilitates the building of more sustainable systems as part of the recovery phase, which favour the prevention and mitigation of future losses and damages.

The study of impacts helps us to connect different governance levels, from the international level to the local level. The impacts of a disaster are intensively felt at the local level, although these impacts can expand to other areas while resources from other levels can be used to respond to the disaster. At the same time, the decisions and investments made at international and national levels strongly guide the efforts made at community and local levels. This report is full of examples of past disasters, which have been analysed to find lessons and gaps, with an attempt to extract most of the information from the post-disaster period. The idea is to move from identifying need to proposing solutions, and although a disaster and its consequences are unique, the approaches followed and actions implemented can provide opportunities for other groups and sectors.

The current report *Science for Disaster Risk Management 2020* provides recommendations to four groups of society that can contribute to reducing disaster risk: policymakers, practitioners (including here civil protection groups), scientists and citizens. The context and its audience are primarily European, although lessons and cases from outside our borders have been included, considering their potential to be applied in a European context.

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