European Commission

Commission staff working document

Overview of natural and man-made disaster risks the European Union may face

Civil Protection & Humanitarian Aid

Commission staff working document

Overview of natural and man-made disaster risks the European Union may face

2020 edition

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ABBREVIATIONS

ATM	Automated teller machine
CAP	Common agricultural policy
CBRN	Chemical, biological, radiological and nuclear
DALY	Disability-adjusted life year
DRMKC	European Commission Disaster Risk Management Knowledge Centre
EAFRD	European Agricultural Fund for Rural Development
ECDC	European Centre for Disease Prevention and Control
ECI	European critical infrastructure
ECMWF	European Centre for Medium-Range Weather Forecasts
ECURIE	European Community Urgent Radiological Information Exchange system
EDO	European Drought Observatory
EEA	European Environment Agency or European Economic Area
EEAS	European External Action Service
EFAS	European Flood Awareness System
EFFIS	European Forest Fire Information System
EFSA	European Food Safety Authority
EIOPA	European Insurance and Occupational Pensions Authority
EMV	Europay, Mastercard, Visa
ENISA	European Union Agency for Cybersecurity
ENSREG	European Nuclear Safety Regulators Group
EPCIP	European Programme for Critical Infrastructure Protection
ERCC	Emergency Response Coordination Centre
ERNCIP	European Reference Network for Critical Infrastructure Protection
ESA	European Space Agency
ESIF	European Structural and Investment Funds
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EUR	Euro
EWRS	Early Warning and Response System
FD	Floods Directive
FRMP	Flood risk management plan
GAR	Global assessment report on disaster risk reduction
GDO	GLOBAL Drought Observatory
GDP	Gross domestic product
GHG	Greenhouse gas

GloFas	Global Flood Awareness System
GNI	Gross national income
GWIS	Global Wildfire Information System
HIV	Human immunodeficiency viruses
IAEA	International Atomic Energy Agency
ICT	Information and communication technologies
iOCTA	Internet organised crime threat assessment
IBPES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IPCR	EU Integrated Political Crisis Response
ISIS	Islamic State of Iraq and the Levant
JRC	Joint Research Centre of the European Commission
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MERS	Middle East respiratory syndrome
NATECH	Natural hazard triggered technological accident
NATO	North Atlantic Treaty Organisation
NDC	Nationally Determined Contribution under the Paris Agreement
NFC	Near Field Communication
NRA	National risk assessment
OECD	Organisation for Economic Co-operation and Development
PESETA	Projection of economic impacts of climate change in sectors of the European Union based on bottom-up analysis
RAN	Radicalisation awareness network
RBMP	River basin management plan
RCP	Representative concentration pathway
SARS	Severe acute respiratory syndrome
SOMA	Observatory for Social Media Analysis
SWD	European Commission staff working document
UAV	Unmanned aerial vehicle
UCPM	Union Civil Protection Mechanism
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNHCR	United Nations High Commissioner for Refugees
WFD	Water framework Directive
WHO	World Health Organisation
WISC	Windstorm Information Service

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EXECUTIVE SUMMARY

This Commission staff working document is the second edition of an overview of the natural and man-made disaster risks that the EU may face, prepared under EU legislation on civil protection. The aim of the overview is to capture the trends in the ever-evolving disaster risk landscape, discuss the major drivers shaping it, take a closer look at 12 selected disaster risks of particular relevance for Europe and to assess the implications of developments in disaster risks for risk management. One of the important sources that fed into the overview are the national disaster risk assessments sent to the Commission by the EU Member States and the participating states to the Union Civil Protection Mechanism during the 2018 reporting cycle. In addition to information from national authorities, the overview draws on the latest available evidence from the Commission's cross-sectoral policy, operational and scientific work on disaster risk. **The purpose of the overview is to foster a sound understanding of disaster risks facing Europe's population and to inform decisions on risk management to prevent loss of life and damages.**

Although Europe is a relatively safe place to live, recent years have shown that Europe is also affected by a wide range of adverse events that cause devastation of human life, property, environment and cultural heritage. The biggest disaster to hit Europe in decades, the COVID-19 pandemic, was still unfolding at the time of writing, having killed more than a million people across the world, overwhelming national healthcare systems, disrupting public life and generating a major shock to economies.

The COVID-19 pandemic is the worst health crisis seen in EU's history, though unfortunately it is not the only extreme event witnessed in recent years. Regions from north to south Europe have experienced episodes of life-threatening heat, with historic temperature records broken several years in a row. The past three years have also seen dramatic wildfires blazing throughout the continent, killing more people and burning more land than ever before. Storms, extreme rainfall events and floods continued to cause damage, with washed-away roads and inundated city streets making news headlines. Hurricanes wreaked havoc in the EU's outermost regions. Some of the strongest earthquakes to hit the EU and neighbouring countries in years sent a reminder of ever-present seismic risk.

Europe also had to deal with threats posed by individuals or groups with malevolent intent. European cities continued to be a target for terrorists. The 2018 attack on civilians in Salisbury, UK involving the military-grade nerve agent Novichok drew attention to the threats linked to the use of chemical, biological, radiological and nuclear (CBRN) materials by hostile individuals or groups. Recent years have also seen some of the most harmful cyberattacks to date. They targeted European democratic processes and government systems, affected critical infrastructure such as hospitals and caused billions of euros of losses to businesses.

Some of these adverse events overwhelmed national response capacity and put considerable pressure on public budgets, prompting EU Member States to seek assistance from EU solidarity instruments, such as the Union Civil Protection Mechanism and the EU Solidarity Fund. Wildfires and floods were the most common disaster events for which countries requested support, while earthquakes were the most destructive.

An analysis of long-term trends suggests that the **damage caused by disaster events in Europe has been on the rise for several decades**. Based on available data, infectious diseases and heatwaves were the biggest 'killers', while storms, floods and earthquakes were the costliest natural hazards in terms of economic loss. **Most of the harm was caused by a few, relatively rare high-impact events**, highlighting the importance of prevention and preparedness for this type of disaster scenario.

In future, we can expect more extreme events and increasing damage due to converging driving forces that are (re)shaping hazards and threats, as well as exposure and vulnerability of our societies to disasters. One of the major drivers of disaster risk is **climate change**. Changes observed in the Earth's climate are triggering

more extreme weather events, sea level rise and changes in the geographical distribution of some infectious diseases. In the EU, reported economic losses from weather extremes are on average already EUR 12 billion per year. Although ambitious action to mitigate climate change is crucial, even cutting all greenhouse gas emissions would not stop the impacts already underway. Research suggests that over the next decades, all of Europe will face worsening impacts of climate change. In southern Europe, an increase in extreme heat, water scarcity, drought and wildfires is forecasted. Northern Europe is expected to experience reduced ice cover and increased temperatures, rainfall and floods. The magnitude of future weather-related risks and impacts will depend on a variety of factors, including levels of development and vulnerability, and on the implementation of climate change adaptation and mitigation measures.

Climate change is not the only driver behind the evolving disaster risk and increasing loss. Over decades, **urbanisation, development in hazardous areas and unsustainable land use** have put more people and wealth in harm's way. Urban settings further amplify disaster risks such as floods, heatwaves or epidemics. The ageing building stock and infrastructure in European cities pose additional challenges due to their vulnerability to seismic and intensifying climatic hazards. As more and more Europeans live in cities – a trend forecast to continue – specific urban vulnerabilities and risk management are becoming a focus of attention.

Land take for urban development and anthropogenic land and sea usage, alongside climate change, pollution and the overuse of natural resources have contributed to **environmental degradation**. Despite conservation and restoration action, ecosystems both on land and sea continue degrading, in Europe and globally, which reduces their capacity to prevent, mitigate and recover from the impacts of disasters.

Whereas the disaster risks associated with natural hazards are evolving gradually, albeit accelerating over time, **the panorama of man-made threats is changing fast**. Recent years have seen growing instability abroad, geopolitical tensions, a decline in multilateralism, new developments in global terrorist threats, and diversification of hostile individuals and groups. All these developments have direct implications for internal security in the EU, including threats such as terrorism, cyber threats and the potential use of CBRN materials. The EU and its Member States face complex hybrid threats that permeate different domains of society, with cyberspace and social media providing new ways of influencing. Rapid technological advancements have given rise to both benefits and to new risks. The growing dependence of modern societies on technology is itself a vulnerability that can be exploited by malevolent individuals or groups.

Against this complex backdrop, it is crucial to have arrangements in place for effective prevention, mitigation, preparedness, response and recovery from disasters in future. In the EU, protecting people, property, environment and cultural heritage against multiple threats is primarily a national responsibility. However, as disasters defy borders, the EU complements, supports and coordinates national action and promotes cross-border cooperation on these matters. A wide set of EU policies and instruments aim to strengthen collective safety and resilience against adverse events in Europe. Although Europe has achieved a high level of protection against disasters, there is no room for complacency as the world is changing fast and new challenges continue to emerge, with the latest COVID-19 health crisis a stark reminder. Emergencies seen in recent years have already triggered a revision of some EU instruments and measures for disaster risk management. More action will be required to make sure we are ready to face the future.

In terms of policy implications, the overview of disaster risks in the EU indicates the following priority areas of action:

(1) addressing the major causes of risk to prevent, for the long-term, loss of life and damage to infrastructure, economy, environment and cultural heritage;
(2) increasing cooperation across borders and sectors, in all phases of risk management, to better address the transboundary nature of disaster risk, the increasing complexity and emergence of new threats;
(3) investing in prevention, preparedness and resilience to disasters, based on a strategic and risk-informed approach;
(4) further boosting the EU's collective capacity to respond to high-impact disasters with transboundary effects;

(5) stepping up action to build resilience of critical infrastructure to intensifying natural hazards and man-made threats;
(6) building financial (fiscal) resilience to disasters in view of the rising economic cost of catastrophic events;
(7) improving the evidence base for effective risk management and building resilience.

As disaster risks are dynamic and evolve over time, systematic monitoring is key to adapting risk management policies to the changing situation on the ground. A regular assessment of disaster risks, capabilities to manage them and regular sharing of risk information at EU level are and will remain important aspects of risk management work carried out under the Union Civil Protection Mechanism. A lot of progress has been achieved in this field, but there is also scope for further development. We need to reflect on how to complement the inherently different national approaches to disaster risk in order to obtain a more comprehensive picture of EU-wide needs to build resilience. We need better data, at all administrative levels, on exposure to risk, vulnerabilities and losses from the past disaster events to be able to better tailor our risk management interventions. Lastly, we need to think more about rare, but potentially catastrophic disaster scenarios, so that we are better prepared for any next emergency of the COVID-19 pandemic type or scale.

1. INTRODUCTION

In the European Union (EU), a robust understanding of disaster risks is considered essential in order to address the risks effectively by framing risk management policies. To this end, the EU civil protection legislation[1] sets out obligations for both the European Commission and the EU Member States. Every three years, Member States must assess their disaster risks and their risk management capabilities and they must share the summary of this assessment with the Commission. In the same spirit, the Commission has the obligation to regularly publish a "*cross-sectoral overview of natural and man-made disaster risks the EU may face, taking a coherent approach across different policy areas that may address or affect disaster prevention and taking due account of the likely impacts of climate change*".

This Commission staff working document gives an overview of the natural and man-made disaster risks the EU may face (hereinafter, the overview). Its main purpose is to help improve awareness of disaster risk and to inform risk management policies in Europe. From this perspective, the overview is published at an opportune moment. Firstly, it comes out at the beginning of the new Commission's term of office and ahead of the EU's next multiannual budgetary period, 2021-2027. This is particularly well-timed as the insights presented in the overview can feed into the new initiatives proposed in the Political Guidelines for the European Commission 2019-2024,[2] in particular for the European Green Deal, the digital agenda or security policy packages. It can also feed into the process of programming EU investment in disaster risk management over 2021-2027 under a range of EU funds. Secondly, and on a less positive note, the overview is published as Europe and the world continue to grapple with the impacts of one of the biggest disasters seen in decades, the COVID-19 pandemic. As the fitness of our crisis management systems is being tested and lessons from this global public health emergency are being learnt, the aim of the overview is to contribute to these reflections by giving a broader perspective on disaster risks in the EU.

The overview is structured as follows. After this introduction, Chapter 2 outlines the EU policy framework for disaster risk management, as background information and as a lens through which to look at risk. In Chapter 3, the focus shifts to trends in the risk landscape, discussing recent disaster events and the major drivers shaping the risks of the future. Chapter 4 presents key findings from the review of national risk assessments sent to the Commission in the 2018 reporting cycle. It focuses on developments both in the national perceptions of disaster risk and the risk assessment process itself. Lastly, Chapter 5 outlines the policy implications of the evolving risk landscape in terms of risk assessment and management in the EU. The broad view of the risk and policy landscape is complemented and should preferably be read together with Annex 1, which presents a detailed analysis of 12 selected disaster risks, namely: extreme weather events, flooding, droughts, wildfires[3], geophysical risks, epidemics/pandemics, animal and plant diseases, nuclear and radiological accidents, disruption of critical infrastructure, industrial accidents, terrorism and cyber threats. These risks were selected for a more in-depth review due to their relevance at European level, taking into account national risk assessments, past disaster events that required the mobilisation of the EU solidarity instruments and an analysis of trends in disaster risk.

This is the second edition of the overview prepared under EU legislation governing civil protection.[4] The previous edition was published in May 2017.[5] Although there is a degree of continuity between the two editions, in particular in terms of the risks covered, the second edition

[1] Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism, as amended by Decision No 2019/420, in particular Articles 5 and 6.

[2] A Union that strives for more. Political Guidelines for the Next European Commission 2019-2024. – Available at https://ec.europa.eu/info/sites/info/files/political-guidelines-next-commission_en_0.pdf

[3] The term "wildfires" includes forest fires and other fires out of control that may burn land-cover types other than forests.

[4] Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism.

[5] SWD(2017) 176 final.

brings in a number of changes. The key purpose of the current publication is to better reflect the dynamic nature of disaster risk and to capture trends in the evolving risk landscape. The starting point was information from the national reports on risks and risk management capabilities submitted by Member States to the Commission in the 2018 reporting cycle. This was complemented with the most recent available evidence collected as part of the Commission's cross-sectoral policy, operational and scientific work.

In terms of geographical scope, the overview focuses on the EU and on the disaster risks faced by its Member States.[6] The cut-off date for the information used is the end of 2019, with a few exceptions, such as the COVID-19 pandemic and Chapter 5 on future policy directions. Given the cut-off date, the UK is included in the overview as an EU Member State.

[6] This is in line with the geographical scope of prevention activities defined in EU legislation on the Union Civil Protection Mechanism, (Article 2 of Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism, amended by Decision No 2019/420).

2. PROTECTING THE EUROPEAN PUBLIC FROM DISASTERS: THE EU POLICY LANDSCAPE

A 'disaster' is any situation which has or may have a severe impact on people, the environment, or property, including cultural heritage.[7]

In the EU, protecting people, property, environment and cultural heritage against multiple threats is primarily a national responsibility. However, as disasters defy borders, the EU can take action to complement, support and coordinate national action and to promote cross-border cooperation. It has a wide range of policies and instruments in place that aim to strengthen the EU's collective safety and resilience against adverse events.

The Union Civil Protection Mechanism (UCPM) is at the heart of cooperation between the EU, its Member States and some third countries (the UCPM participating states[8]) on civil protection against natural hazards and man-made threats.[9] Since it was set up in 2001, the Mechanism has gradually evolved from an instrument to provide emergency response coordination to a more comprehensive framework incorporating action on disaster prevention and preparedness. Under the UCPM, Member States and participating states regularly exchange information on disaster risks, run exercises together to better prepare for emergencies and pool rescue teams and equipment that can be rapidly mobilised when a disaster overwhelms a Member State or any other country in the world. In recent years, the changing risk landscape, the experience of several consecutive deadly wildfire seasons and, most recently, a pandemic have revealed the limitations of the Mechanism.

7 Article 4 of Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism, amended by Decision No 2019/420.

8 In addition to the EU Member States, in 2018-2019, six third countries participated in the Union Civil Protection Mechanism: Iceland, Norway, Serbia, North Macedonia, Montenegro, and Turkey.

9 In the event of consequences of acts of terrorism or radiological disasters, the Union Civil Protection Mechanism only covers preparedness and response action.

This has triggered several reforms that aim to boost the EU's collective ability to deal with disasters (see Box 1 and section 5.4 for more details).

In addition to the UCPM, a wide range of EU sectoral legislation address specific disaster risks. Some of these pieces of legislation, for example on technological accidents, have been in force for several decades and have played an important role in reducing and effectively managing related risks. Several generations of the Seveso Directive on the prevention and control of major industrial accidents have resulted in the low number of casualties in such accidents, despite the EU having a high industrialisation rate. The Directive has also served as a model for industrial accident policy in many countries worldwide.[10] Moreover, since 1998, the EU has been a party to the UNECE Convention on the Transboundary Effects of Industrial Accidents, which helps address industrial accidents that have transboundary effects. Similarly, an EU-wide approach to nuclear safety and security has helped ensure that nuclear energy operations in all Member States are carried out and enforced with the highest standards.[11] The European Critical Infrastructure Protection Directive[12] generated political momentum and spurred national action on the protection of critical infrastructure against multiple hazards and threats.[13] However, evolving threats and the changing nature of critical infrastructure itself have led to a discussion on the future of critical infrastructure protection policy in the EU.

Regarding natural hazards, the EU Floods Directive[14] of 2007 is a signature EU risk management instrument. The Directive, backed by cohesion policy funding, cross-border[15] and transnational[16] cooperation and the European Floods Awareness System, has increased protection against flooding and helped avoid the recurrence of disastrous pan-European fluvial floods of the magnitude seen in 2002.

The importance of taking concerted action and putting in place arrangements at EU level to tackle other cross-border threats such as epidemics[17] has never been more evident than today, with the COVID-19 pandemic leaving no EU Member State unaffected. In a related field, the longstanding and recently modernised EU rules on animal and plant health have contributed to better prevention and control of transmissible animal and plant diseases that can have significant public health and economic impacts.

As regards protecting the EU public from security-related threats such as terrorism and cyber threats, a broad spectrum of legislative and operational initiatives have been undertaken under the security union agenda.[18] The EU is working to counter terrorism by closing down the space in which terrorists operate, making it harder for them to access explosives, firearms and financing, stepping up information exchange between law enforcement authorities, strengthening EU external border protection and addressing the problem of radicalisation. Over the past several years, the EU, guided by the cybersecurity strategy[19], has also been scaling up action to address rapidly growing cyber threats. This has included strengthening the legal, technical and operational capabilities of law enforcement agencies to deter potential attackers, as well as measures to counter disinformation and build cyber resilience, including the resilience of digital critical infrastructure.[20] [21] Work has also been intensifying on countering hybrid threats and threats linked to the potential use

[10] The European Commission. Major accident hazards – Available at https://ec.europa.eu/environment/seveso/

[11] Joint Research Centre of the European Commission. Science for nuclear safety and security. JRC thematic report, 2014, available at https://publications.jrc.ec.europa.eu/repository/bitstream/JRC90424/lbna26659enn.pdf.

[12] Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection (Text with EEA relevance). *OJ L 345, 23.12.2008.*

[13] SWD(2019) 308.

[14] Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (Text with EEA relevance). *OJ L 288, 6.11.2007.*

[15] In the meaning of cooperation of neighbouring regions on both sides of a shared border.

[16] In the meaning of cooperation of contiguous regions in a broader area such a sea basin or a mountain chain.

[17] Decision No 1082/2013/EU of the European Parliament and of the Council of 22 October 2013 on serious cross-border threats to health and repealing Decision No 2119/98/EC (Text with EEA relevance).

[18] COM(2016) 230 final.

[19] JOIN(2017) 450 final.

[20] The European Commission, Cybercrime. Available at https://ec.europa.eu/home-affairs/what-we-do/policies/cybercrime_en

[21] The European Commission, Cybersecurity. Available at https://ec.europa.eu/digital-single-market/en/cyber-security

of chemical, biological, radiological and nuclear (CBRN) materials. Given the inherent complexity of hybrid and CBRN threats and their potentially grave consequences, the EU is stepping up cross-sectoral cooperation between law enforcement, civil protection and the military in order to be better prepared for dangerous disaster scenarios.

Over and above tackling specific risks, the EU is active in addressing the main drivers of disaster risk, in particular climate change. It is taking action to combat climate change on three main fronts, in line with its commitment to the full implementation of the Paris Agreement. Firstly, the EU is stepping up mitigation action in order to achieve climate-neutrality by 2050 and to avoid the most dangerous impacts of climate change. Secondly, the EU is supporting adaptation to climate change at the EU, national and sub-national levels through action set out in the EU strategy on adaptation to climate change.[22] And thirdly, the EU is cooperating with international partners to achieve the goals of the Paris Agreement and to support developing countries in making the transition to low-carbon and climate-resilient economies and societies. The EU remains the largest provider of climate change finance internationally, dedicating an increasing share of funding to climate change adaptation.

The EU has also mobilised significant financial resources to support investment in disaster resilience across Europe. The largest source of EU funding in this area is the European Structural and Investment Funds (ESIF). Over the period 2014-2020, Member States and regions allocated approximately EUR 10 billion of ESIF funding to investment in climate change adaptation, risk prevention and management. Of this amount, around EUR 2 billion came from the European Agricultural Fund for Rural Development and EUR 8 billion from the European Regional Development Fund and the Cohesion Fund (*Figure 1*). A share of the funding goes to supporting cross-border and transnational cooperation activities, which are particularly important given the transboundary nature of disaster risk. In addition to funding, the EU macro-regional strategies[23] provide useful platforms for regional coordination of investment in disaster risk management and climate change adaptation, for implementing strategic projects and for cooperating across sectors, governance levels and stakeholders.

[22] COM(2013)216 final.

[23] The European Commission. Macro-regional strategies, available at https://ec.europa.eu/regional_policy/fr/policy/cooperation/macro-regional-strategies/

In addition to investing in better prevention and preparedness, the EU provides financial support to national emergency and recovery operations in the aftermath of major disasters. The key instrument by which it does so is the EU Solidarity Fund. Since its creation in 2002, the Fund has supported 23 EU Member States and one candidate country cope with 88 disasters for the total amount of EUR 5.5 billion (see section 3.1.2. for more details).

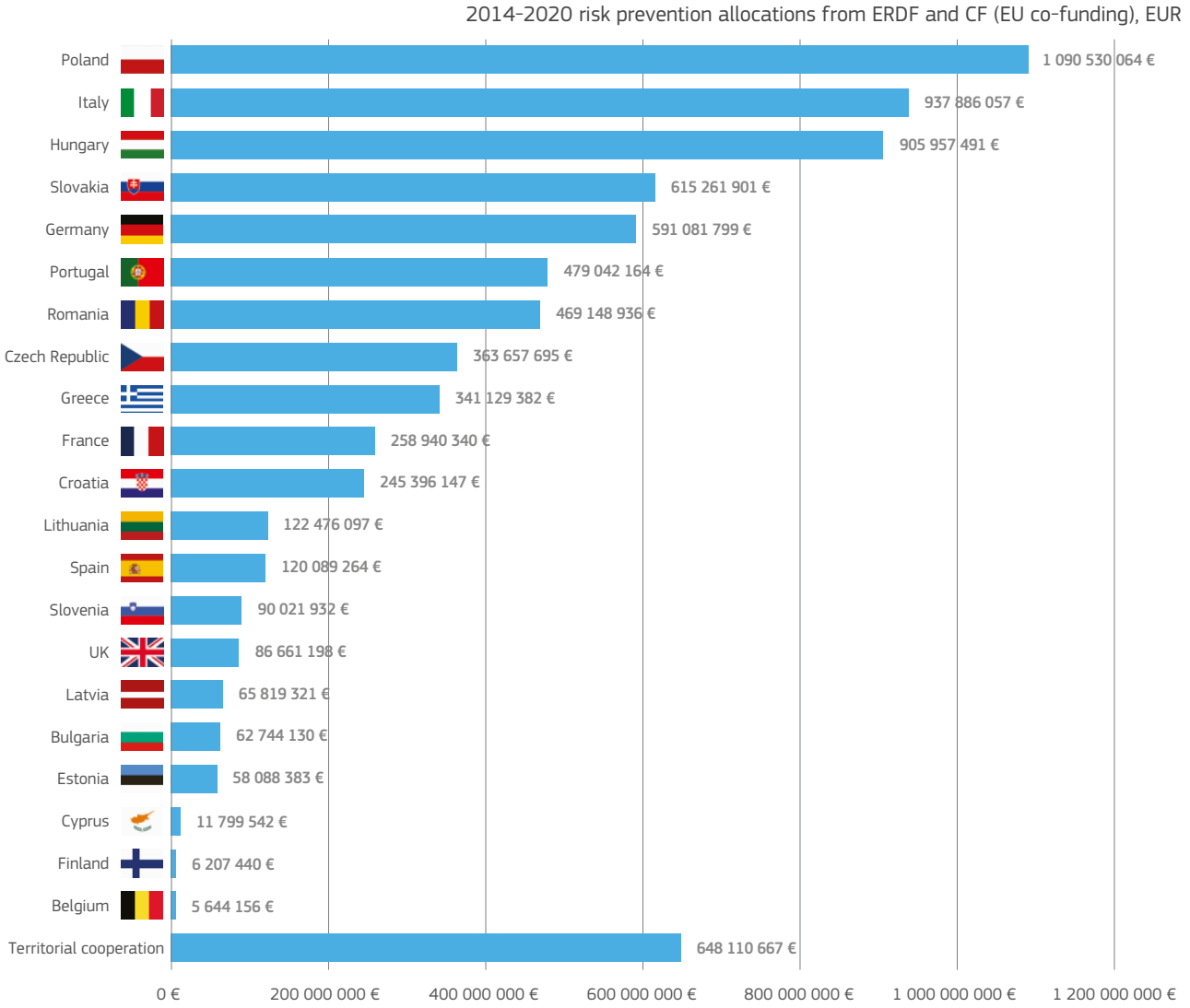


Figure 1. Cohesion policy funding for risk prevention and management in 2014-2020[24]

[24] The European Commission. Cohesion policy: preventing risks, available at https://cohesiondata.ec.europa.eu/stories/s/Cohesion-policy-preventing-risks/j9ce-3mtn/

Disaster risk management is mainstreamed in several other EU funding instruments. Over the 2014-2019 period, approximately EUR 1 billion under the Horizon 2020 programme[25] have been channelled to research and innovation projects that aim to better prevent, prepare for, respond to and recover from disasters and the adverse impacts associated with climate change (approx. EUR 535 million), health-related issues (approx. EUR 175 million), security issues and crisis management (approx. EUR 160 million).[26] The EU LIFE programme[27] funds climate-related action, the Internal Security Fund provides financial support for capacity building measures related to security risks, and the EU Health programme[28] finances projects contributing to better protection of the EU public from serious cross-border health threats. The European Investment Bank supports disaster risk management projects through loans and financial and technical expertise, such as JASPERS[29].

EU policies and funds take into account the specific vulnerabilities and needs that some parts of European society have in terms of disaster risk. For example, as most Europeans now live in cities, urban safety and security challenges receive special attention also at EU level. The EU strategy on adaptation to climate change,[30] the EU urban agenda,[31] cohesion policy funds and several other financial instruments have provided support for local action on mitigation and adaptation to climate change, for nature-based solutions in cities, for the protection of urban public spaces against terrorist attacks and for preparedness for CBRN risks. The EU also supports the EU and Global Covenants of Mayors[32] that bring together thousands of local governments voluntarily committed to implementing EU climate and energy objectives.

Disaster and climate resilience is a priority not only in cities. Under the common agricultural policy, there are dedicated measures that support farmers facing economic losses caused by extreme climatic events, animal or plant diseases and other risks. These support measures include risk management schemes that provide contributions to insurance policies, compensations to mutual funds, and investment in restoration of the agricultural production potential and risk prevention measures.

Yet another example is the EU's outermost regions[33] which can benefit from lower damage thresholds set for accessing the EU's Solidarity Fund assistance after a disaster.[34] This is important as the EU's outermost regions are exposed to specific disaster risks such as hurricanes, and they are also more vulnerable due to their remoteness, their small size and insularity.

In addition to legislative, policy and financial measures, the EU supports disaster risk management with early warning systems, data and scientific knowledge. The Copernicus programme is one of the signature EU initiatives providing emergency services and other disaster risk management bodies with timely and accurate geo-spatial information from satellites and non-space monitoring systems. Maps and data produced by Copernicus, together with the European early warning systems on floods, wildfires and droughts, are now widely used by emergency authorities across Europe as input to their decisions on crisis response, prevention, preparedness and recovery operations[35] (see Box 8 for more details on the Copernicus programme).

25 Horizon 2020 – Available at https://ec.europa.eu/programmes/horizon2020/

26 Data from the Horizon 2020 Dashboard platform, available at https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-dashboard; last accessed on 23 June 2020.

27 LIFE programme – Available at https://ec.europa.eu/easme/en/life

28 EU Health programme – Available at https://ec.europa.eu/health/funding/programme/2014-2020_en

29 JASPERS. Joint Assistance to Support Projects in European Regions, available at https://jaspers.eib.org/

30 COM(2013) 216 final.

31 The European Commission, Urban Agenda for the EU, available at https://ec.europa.eu/futurium/en/urban-agenda

32 EU Covenant of Mayors for climate and energy, available at https://www.covenantofmayors.eu/en/ and Global Covenant of Mayors for climate and energy, available at https://www.globalcovenantofmayors.org/

33 Guadeloupe, French Guiana, Martinique, Saint-Martin, Réunion, Mayotte (France); the Canary Islands (Spain); and the Azores and Madeira (Portugal).

34 Damage exceeding 1% of regional GDP, whereas for other regions it is 1.5% of regional GDP.

35 Copernicus. Europe's eyes on Earth – Available at https://www.copernicus.eu/en/about-copernicus

Since 2015, the European Commission's Disaster Risk Management Knowledge Centre (DRMKC) has played an important role in providing scientific data and advice for disaster risk management policies and in translating complex science into information that is usable for decision-making. The work of the DRMKC is based on a multi-disciplinary and multi-level approach, bringing together different Commission departments, EU Member States and other bodies in the disaster risk management community within and beyond the EU. The data, knowledge and intelligence is publicly accessible on the DRMKC web platform.[36]

Lastly, disaster risk management at EU level is closely linked to global initiatives, such as the Sendai Framework for Disaster Risk Reduction 2015-2030. Although the European Commission is not a signatory to the Sendai Framework, it played a leading role in the international negotiations, supports EU Member State signatories and third countries in implementing the Agreement, and seeks to ensure EU action is complementary to and coherent with global action on disaster risk management.

All the measures outlined above have contributed to the high level of safety and security that Europeans enjoy today. EU policies and instruments have evolved and have taken into account changes in the risk landscape, lessons learnt from past disasters, new scientific knowledge, international developments and opportunities offered by new technologies. Notwithstanding the progress achieved, the following chapter shows that there is no room for complacency as the world is changing fast and new challenges continue to emerge, testing the fitness of our risk management instruments and approaches. The following chapter focuses on developments in the risk landscape. It starts with an overview of recent disaster events and the lessons learnt from them, and then shifts the focus to longer-term trends and the driving forces shaping the broader risk panorama.

[36] Disaster Risk Management Knowledge Centre (DRMKC), available at https://drmkc.jrc.ec.europa.eu/overview/About-the-DRMKC

3. THE CHANGING RISK LANDSCAPE IN EUROPE

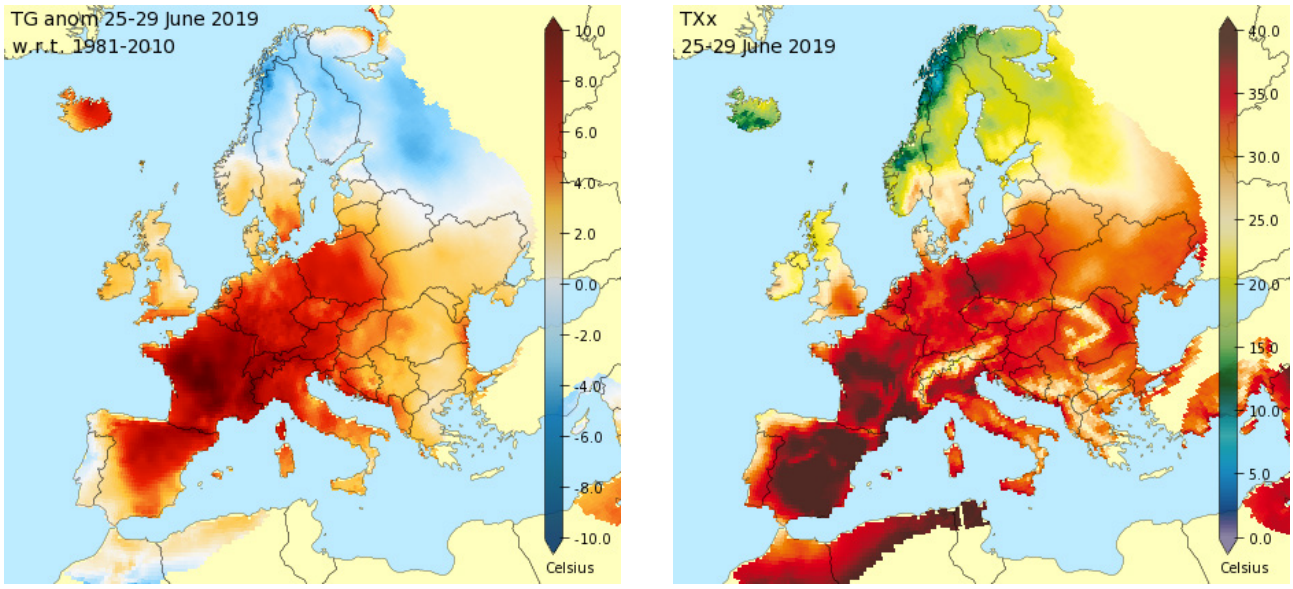
3.1. Lessons from the past

3.1.1. Recent disasters in the EU

Over the past few years, Europeans have faced multiple emergencies that have caused devastation of human life, property, to the environment and to cultural heritage. Disasters have struck in all parts of the EU, some more extreme than ever or affecting locations that had not seen such threats before.

The biggest emergency event to hit Europe in decades was still unfolding at the time of writing. Infectious disease COVID-19, caused by a novel virus unknown to infect humans before December 2019, broke out into a global pandemic in a matter of a few months, killing more than a million people across the world, overwhelming national healthcare systems, disrupting public life and triggering a major economic shock.

Although the COVID-19 pandemic is the worst health crisis seen in the EU's history, it is not the only adverse event witnessed in recent years. Europe has also had to grapple with extreme weather and with other disasters caused by natural hazards, some of which occurred with new intensity and patterns. Regions from north to south have faced life-threatening heatwaves (*Figure 2*), with historic temperature records broken several years in a row. Heatwaves have caused death, disrupted critical infrastructure, and have exacerbated drought and wildfires.



(a) *(b)*

Figure 2. Maximum value of the daily maximum temperature (°C) (*a*) and daily averaged temperature anomalies (°C) compared with the long-term mean, over 25-29 June 2019 (*b*).[37]

[37] Copernicus, State of the European Climate: June 2019, available at http://surfobs.climate.copernicus.eu/stateoftheclimate/june2019.php, last accessed on 12 August 2019.

The past three years have seen dramatic wildfires blazing throughout the continent, including in such unusual locations as the Arctic or in wetlands.[38] They have killed more people and burnt more land than ever before, and overwhelmed national and EU response capacity. Storms, extreme rainfall and floods have continued to cause damage, with washed-away roads and inundated city streets making news headlines. Hurricanes wreaked havoc in the EU's outermost regions, with the 2017 Hurricane Irma in Saint-Martin and 2019 Hurricane Lorenzo in the Azores being particularly destructive.

Some of the strongest earthquakes to hit the EU and neighbouring countries in years were reminders of the ever-present seismic risk. A series of quakes that shook central Italy in 2016-2017 killed hundreds of people, reduced historic buildings to rubble and caused over EUR 22 billion of direct damage.[39] In March 2020, in the midst of the ongoing COVID-19 crisis, Croatia was hit by its biggest earthquake in 140 years, triggering the evacuation of hospitals and putting additional pressure on its already strained emergency services, demonstrating the complexity of managing simultaneous or consecutive disasters.

In addition to adverse events caused by natural hazards, Europe has also had to deal with threats posed by individuals or groups with malevolent intent. European cities were the target of terrorist attacks, though thankfully fewer lives were lost in recent years than during the tragic events of 2015-2016. The 2018 attack on civilians in Salisbury in the UK involving the military-grade nerve agent Novichok highlighted the threats that materialise if chemical, biological, radiological and nuclear materials are used by hostile individuals or groups. Recent years have also seen some of the most harmful cyberattacks to date, targeting European democratic processes and government systems, affecting critical infrastructure such as hospitals and causing billions of euros of losses to businesses.

Some of these adverse events overwhelmed national response capacity and put considerable pressure on public budgets, prompting Member States to seek assistance from EU solidarity mechanisms, such as the UCPM and the EU Solidarity Fund. The following section presents statistics on the use of these instruments to support disaster response and recovery in Europe. The overview provides insights on the type of events that tended to strain national capacity and cause the greatest damage, both over the recent past and taking a longer-term perspective. The section also discusses how the disasters faced in recent years have prompted the revision of the EU's solidarity mechanisms to adapt them to changing circumstances.

3.1.2. Use of EU solidarity instruments for assistance with disasters

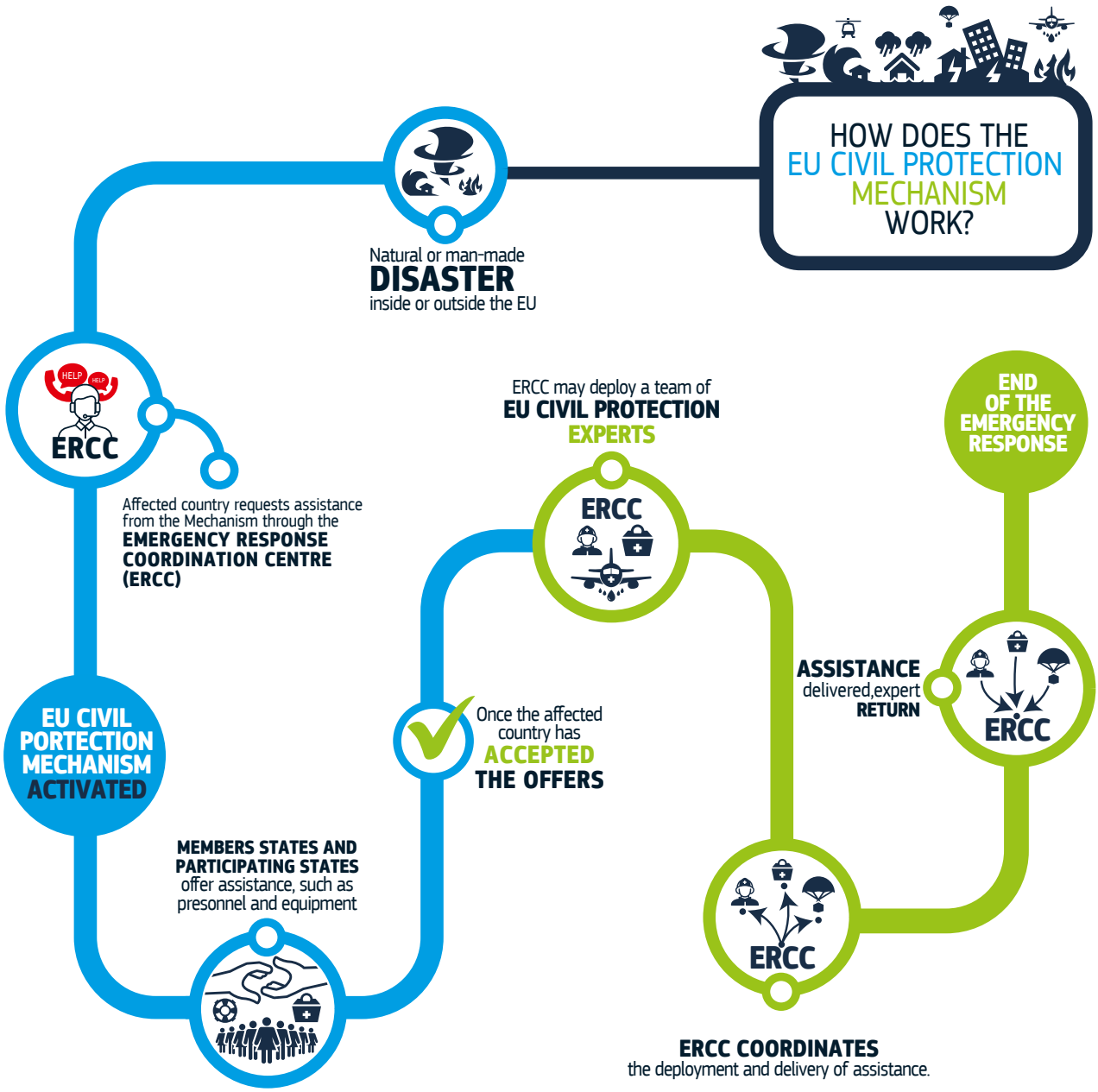
3.1.2.1. Support under the Union Civil Protection Mechanism for emergency response in Europe

When faced with large-scale emergencies that strain or overwhelm national response capacity, countries inside and outside the EU can request international assistance under the UCPM. The UCPM assists with all types of emergency, irrespective of whether it is caused by natural hazards or by human action.

Both historically and in recent years, wildfires have been the most common type of disaster prompting countries in Europe to request assistance. A record number of requests for help fighting wildfires was received in 2017, when southern Europe experienced a particularly severe fire season (*Figure 3*).

[38] The European Commission, Reports on Forest Fires in Europe, Middle East and North Africa, available at https://effis.jrc.ec.europa.eu/reports-and-publications/annual-fire-reports/

[39] Damage estimate based on data provided by Italy in its application for assistance under the EU Solidarity Fund.


HOW DOES THE EU CIVIL PROTECTION MECHANISM WORK?
Natural or man-made
DISASTER
inside or outside the EU
ERCC
Affected country requests assistance from the Mechanism through the
EMERGENCY RESPONSE COORDINATION CENTRE (ERCC)
EU CIVIL PORTECTION MECHANISM ACTIVATED
MEMBERS STATES AND PARTICIPATING STATES
offer assistance, such as presonnel and equipment
Once the affected country has
ACCEPTED
THE OFFERS
ERCC may deploy a team of
EU CIVIL PROTECTION
EXPERTS
ERCC
ERCC
ERCC COORDINATES
the deployment and delivery of assistance.
ASSISTANCE
delivered,expert
RETURN
ERCC
END OF THE EMERGENCY RESPONSE

	Accident	Earthquake	Floods	Forest fires	Health emergency	Marine pollution	Population displacement	Severe weather	Other	Request for UCPM assistance
2007				11						11
2008		1	1	3						5
2009	1	1		7	1					10
2010	2		4	4				2		12
2011	1	1		1		1			1	5
2012				7			1	3		11
2013				1			1			2
2014	2		2	2				1		7
2015			1	1			6			8
2016			1	4			3			8
2017	1			12			1		1	15
2018				6	1	2				9
2019	1			1		1				3
Request for UCPM assistance	8	3	9	60	2	4	12	6	2	**106**

Figure 3. Requests for UCPM assistance from EU Member States / UCPM participating states by type of disaster, 2007-2019

	Accident	Earthquake	Floods	Forest fires	Health emergency	Marine pollution	Population displacement	Severe weather	Other	Request for UCPM assistance
Bulgaria				3	1	1	1	1		7
Croatia			1				1			2
Cyprus	2			3						5
Finland	1									1
France	1			5		2			1	9
Germany									1	1
Greece	1	1		16			4			22
Hungary	1		1				2			4
Ireland	1									1
Italy		1		7						8
Latvia				1						1
Montenegro			1	5				1		7
Netherlands								1		1
North Macedonia			2	1						3
Norway	1									1
Poland			1							1
Portugal				15						15
Romania			2		1					3
Serbia			1				2			3
Slovakia								1		1
Slovenia				1			1	1		3
Spain						1				1
Sweden				3						3
Turkey		1					1			2
United Kingdom								1		1
Request for UCPM assistance	8	3	9	60	2	4	12	6	2	**106**

Figure 4. Requests for UCPM assistance by EU Member State / UCPM participating state, 2007-2019

In 2017, faced with multiple requests to respond to the same type of disaster (wildfires), the UCPM was not always able to offer the much-needed assistance since the emergencies were taking place simultaneously and there was insufficient response capacity to meet all needs. Drawing on this experience and given the risk outlook in the context of climate change, the Commission proposed to strengthen the UCPM *(Box 1)*.

Box 1. Boosting the EU's capacity to deal with disasters: the 2019 reform of UCPM

In autumn 2017, the Commission put forward a proposal to revise the UCPM legislation[40] with the triple objective of: (i) boosting the EU's collective ability to respond to disasters, (ii) improving prevention, and (iii) simplifying administrative procedures for a more agile response. The revised UCPM legislation entered into force in spring 2019.[41]

The revised UCPM legislation strengthened the incentives for Member States to offer their own emergency response capacities to the **European Civil Protection Pool** – i.e. the primary pool of collective capacities from which EU assistance is drawn in emergencies. In addition to reinforcing the European Civil Protection Pool, the legislation brought in a new reserve of European response capacities called "**rescEU**". This reserve is designed to be an additional safety net, to be mobilised in worst-case disaster scenarios, when emergency assistance from the Pool cannot be mobilised or is not sufficient. When designing the new rescEU reserve, Member States decided to prioritise aerial fire-fighting, medical emergencies and accidents involving CBRN materials.

The reform included new provisions on **risk management** and information sharing between Member States and the Commission as a basis for building a better collective understanding, prevention of and preparedness for risks that may potentially lead to overwhelming disasters in Europe. In particular, there is an increased focus on sharing of information concerning cross-border risks and risks that may have a low likelihood but a potentially high impact.

The revised legislation paves the way for the creation of the **Union Civil Protection Knowledge Network** to help build a shared culture of disaster preparedness in Europe through training, joint exercises and knowledge sharing.

[40] COM(2017) 772 and COM(2017) 773 final.

[41] Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism, amended by Decision (EU) 2019/420.

Shortly after the UCPM was revised, a new emergency of an unprecedented magnitude, the COVID-19 pandemic, has once again tested the ability of EU mechanisms to respond to large-scale disasters. The global health crisis has triggered a record number of requests ever received under the UCPM, as Member States and third countries simultaneously contacted the UCPM for help. At the beginning of the crisis, most requests for medical support could not be met or were met with significant delays, as the items requested (e.g. personal protective equipment, ventilators) were in very short supply globally. Faced with these challenges, the Commission accelerated the build-up of a rescEU stockpile of medical equipment. It also proposed mobilising additional resources to increase the resilience of the EU and the Member States to health crises through the new EU4Health programme for 2021-2027.[42] (For more information on the COVID-19 pandemic and the EU emergency response, see Annex 1, section on 'Epidemics and pandemics').

3.1.2.2. EU Solidarity Fund financial assistance for emergency and recovery operations

In addition to UCPM assistance in emergencies, EU Member States and accession countries can request financial aid from the EU Solidarity Fund in the aftermath of a major national or severe regional natural disaster. The Fund can alleviate the financial pressure on national authorities by funding a share of public expenditure spent on emergency and recovery operations. The amount of financial aid is calculated based on the total direct damage caused by a disaster in relation to the affected country's or region's wealth (GNI and GDP respectively).

Since the Fund was created in 2002, floods have been the most frequent disasters and earthquakes have been the most destructive disasters for which countries have requested financial aid. The Fund has also been mobilised in the aftermath of storms, hurricanes, wildfires, droughts and other severe weather events. Earthquakes in Italy in 2016 and 2017 were the most devastating disaster events in terms of the physical damage caused. They triggered the largest pay-out from the EU Solidarity Fund assistance since it was created, until 2019 *(Figure 5-Figure 7).*

[42] COM/2020/405 final.

	Drought and fires	Drought	Earthquake	Severe weather	Floods	Forest fires	Volcano eruption	Other	Total diect damage
2002			1 558 000 000 €		15 135 000 000 €		894 000 000 €		17 587 000 000 €
2003					815 000 000 €	1 281 000 000 €		436 000 000 €	2 532 000 000 €
2004				203 000 000 €					203 000 000 €
2005				2 553 000 000 €	2 590 000 000 €				5 143 000 000 €
2006					891 000 000 €				891 000 000 €
2007				5 470 000 000 €	4 845 000 000 €	2 118 000 000 €			12 433 000 000 €
2008		165 000 000 €			471 000 000 €				636 000 000 €
2009			10 212 000 000 €	3 806 000 000 €	521 000 000 €				14 539 000 000 €
2010				1 425 000 000 €	7 999 000 000 €				9 424 000 000 €
2011			843 000 000 €		723 000 000 €				1 566 000 000 €
2012	807 000 000 €		13 274 000 000 €		382 000 000 €				144 630 000 00 €
2013					10 309 000 000 €				10 309 000 000 €
2014			147 000 000 €	429 000 000 €	4 666 000 000 €				5 242 000 000 €
2015			66 100 000 €	243 000 000 €	2 807 900 000 €				3 117 000 000 €
2016	181 000 000 €		21 879 000 000 €		1 259 000 000 €	157 000 000 €			23 476 000 000 €
2017			155 400 000 €	2 447 000 000 €	878 500 000 €	1 587 000 000 €			5 067 900 000 €
2018					7 284 000 000 €				7 284 000 000 €
2019				182 000 000 €					182 000 000 €
Total diect damage	988 000 000 €	165 000 000 €	48 134 500 000 €	16 758 000 000 €	61 576 400 000 €	5 143 000 000 €	894 000 000 €	436 000 000 €	134 094 900 000 €

Figure 5. Total direct damage incurred in disasters, as declared in applications to the EU Solidarity Fund, 2002-2019

	Drought	Drought and fires	Earthquake	Floods	Forest fires	Oil spill	Volcano eruption	Severe weather	Total EUSF aid
2002			30 800 000 €	728 000 000 €			16 800 000 €		775 600 000 €
2003				20 560 000 €	49 800 000 €	8 600 000 €			78 960 000 €
2004								5 700 000 €	5 700 000 €
2005				106 300 000 €				92 900 000 €	199 200 000 €
2006				24 400 000 €					24 400 000 €
2007				170 600 000 €	89 800 000 €			185 000 000 €	445 400 000 €
2008	7 600 000 €			11 800 000 €					19 400 000 €
2009			493 800 000 €	13 000 000 €				109 400 000 €	616 200 000 €
2010				250 200 000 €				35 600 000 €	285 800 000 €
2011			21 100 000 €	18 100 000 €					39 200 000 €
2012		2 500 000 €	670 200 000 €	14 627 000 €					687 327 000 €
2013				414 400 000 €					414 400 000 €
2014			3 700 000 €	154 700 000 €				18 400 000 €	176 800 000 €
2015			1 600 000 €	70 200 000 €				6 400 000 €	78 200 000 €
2016		7 300 000 €	1 196 800 000 €	31 500 000 €	3 900 000 €				1 239 500 000 €
2017			3 900 000 €	36 900 000 €	53 900 000 €			61 200 000 €	155 900 000 €
2018				293 600 000 €					293 600 000 €
2019								4 600 000 €	4 600 000 €
Total EUSF aid	7 600 000 €	9 800 000 €	2 421 900 000 €	2 358 887 000 €	197 400 000 €	8 600 000 €	16 800 000 €	519 200 000 €	5 540 187 000 €

Figure 6. EU Solidarity Fund assistance granted, breakdown by disaster type and year, 2002-2019

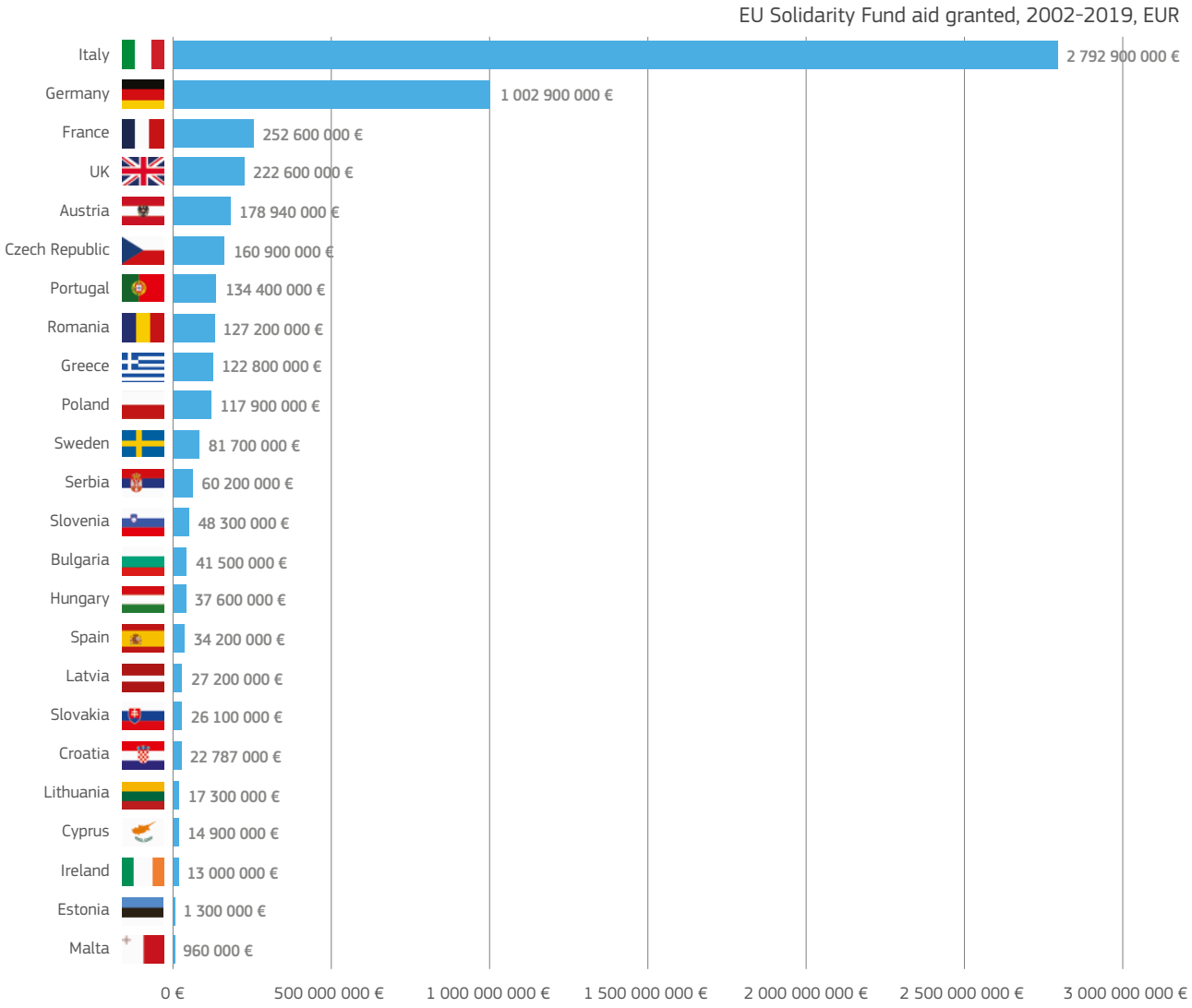


Figure 7. EU Solidarity Fund assistance granted by country, 2002-2019

Box 2. The EU Solidarity Fund: findings from the 2019 evaluation

In 2019, the Commission published an evaluation of the EU Solidarity Fund, covering the period since it was set up in 2002 to 2017.[43] The evaluation concluded that overall, the EU Solidarity Fund remained a **relevant and valuable** instrument in the EU's toolkit for action in the event of disasters. It also identified several weaknesses and areas to address. One of the main shortcomings it highlighted was the **lack of alignment between the "Build Back Better" principle and the Fund's eligibility** conditions, as the Fund can only finance the restoration of damaged infrastructure up to its original state before the disaster hit. Therefore it can be a disincentive to re-building infrastructure in line with newer, more robust standards in order to make it more resilient to future disasters. The evaluation also identified **potential risk of depleting Fund's limited budget** should the EU be faced with several large-scale disasters over a relatively short period of time. Furthermore, the assessment revealed that EU Solidarity Fund support to countries varied not only in terms of the impact caused by a disaster, but also in terms of the capacity of applicants to provide **timely and complete estimates of the total direct damage** incurred, including estimates of private damage. This highlights the importance of having effective systems for collecting data on disasters and related losses.

[43] SWD(2019) 186 final.

Originally, the EU Solidarity Fund was not designed to be used in biological disasters such as the COVID-19 pandemic. However, given the unprecedented challenges and financial strain caused by this emergency, the Commission proposed to revise the EU Solidarity Fund legislation to include responding to major public health crises in its scope.[44] The amending regulation was adopted on 31 March 2020.

3.1.3. The toll of past disasters

The full impact of disasters experienced in recent years remains to be seen as there is typically a time lag between when an adverse event occurs, when all the consequences it generates materialise, and when the data on the losses incurred become available. However, although the public health emergency is still unfolding at the time of writing, it can already be anticipated that the COVID-19 pandemic will be the costliest disaster event to hit Europe in decades. By the end of August 2020, coronavirus had already infected nearly 2 million Europeas, killed over 130 000 people[45] and tipped the EU economy into a sharp recession.[46]

A look at the statistics on infectious diseases in the EU over the last 40 years reveals that mortality linked to infectious diseases is significantly higher than for all other hazards discussed in this report. More worryingly still, it has been on the rise for several decades *(Figure 8)*.

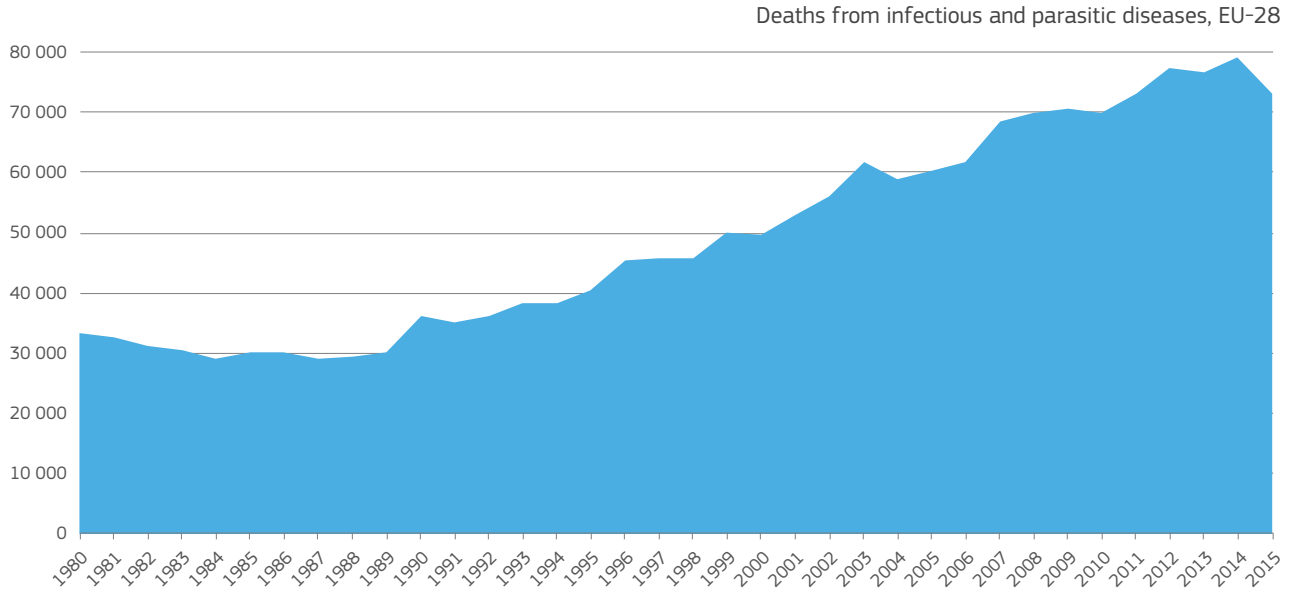


Figure 8. Mortality from infectious and parasitic diseases, EU-28, 1980-2015. Source: WHO[47]

Another hazard that has contributed to substantial loss of life in the past are heatwaves. Heatwaves accounted for 85% of the 91 455 fatalities caused by weather-related and geophysical disasters in the EU over the period 1980-2017[48] *(Figure 9)*. Most of these fatalities were recorded during two heatwaves that occurred in 2003 and 2013.

[44] COM(2020) 114 final.

[45] On 31 August 2020, in the EU-27, there were 1,866,791 confirmed cases and the death toll stood at 139,793. Source: European Centre for Disease Prevention and Control, available at https://qap.ecdc.europa.eu/public/extensions/COVID-19/COVID-19.html

[46] The European Commission, Summer 2020 Economic Forecast: A deeper recession with wider divergences, 7 July 2020, available at https://ec.europa.eu/info/business-economy-euro/economic-performance-and-forecasts/economic-forecasts/summer-2020-economic-forecast-deeper-recession-wider-divergences_en

[47] World Health Organisation, European Health Information Gateway, Infectious and parasitic diseases, number of deaths, available at https://gateway.euro.who.int/en/indicators/hfamdb_389-deaths-infectious-and-parasitic-diseases/visualizations/#id=30175&tab=notes

[48] The European Environment Agency collects information on fatalities and economic losses from disasters caused by natural hazards. The data is provided by the NatCatSERVICE of the Munich Reinsurance Company. It covers geophysical events (earthquakes, tsunamis, volcanic eruptions), meteorological events (storms), hydrological events (floods, mass movements), climatological events (cold waves, heatwaves, droughts, forest fires). Available at https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2

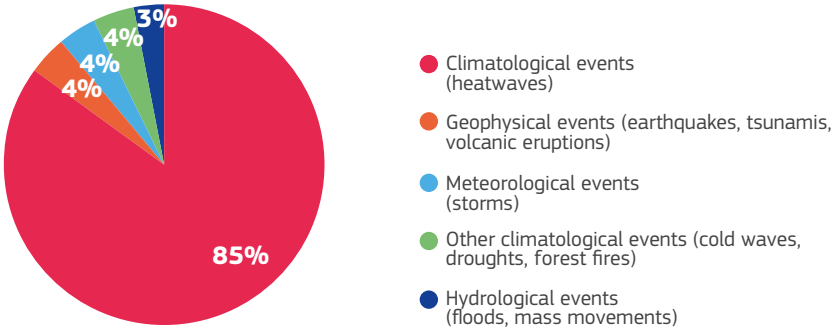


Figure 9. Fatalities caused by selected natural hazards, EU-28, 1980-2017. Source: MunichRe/EEA[49]

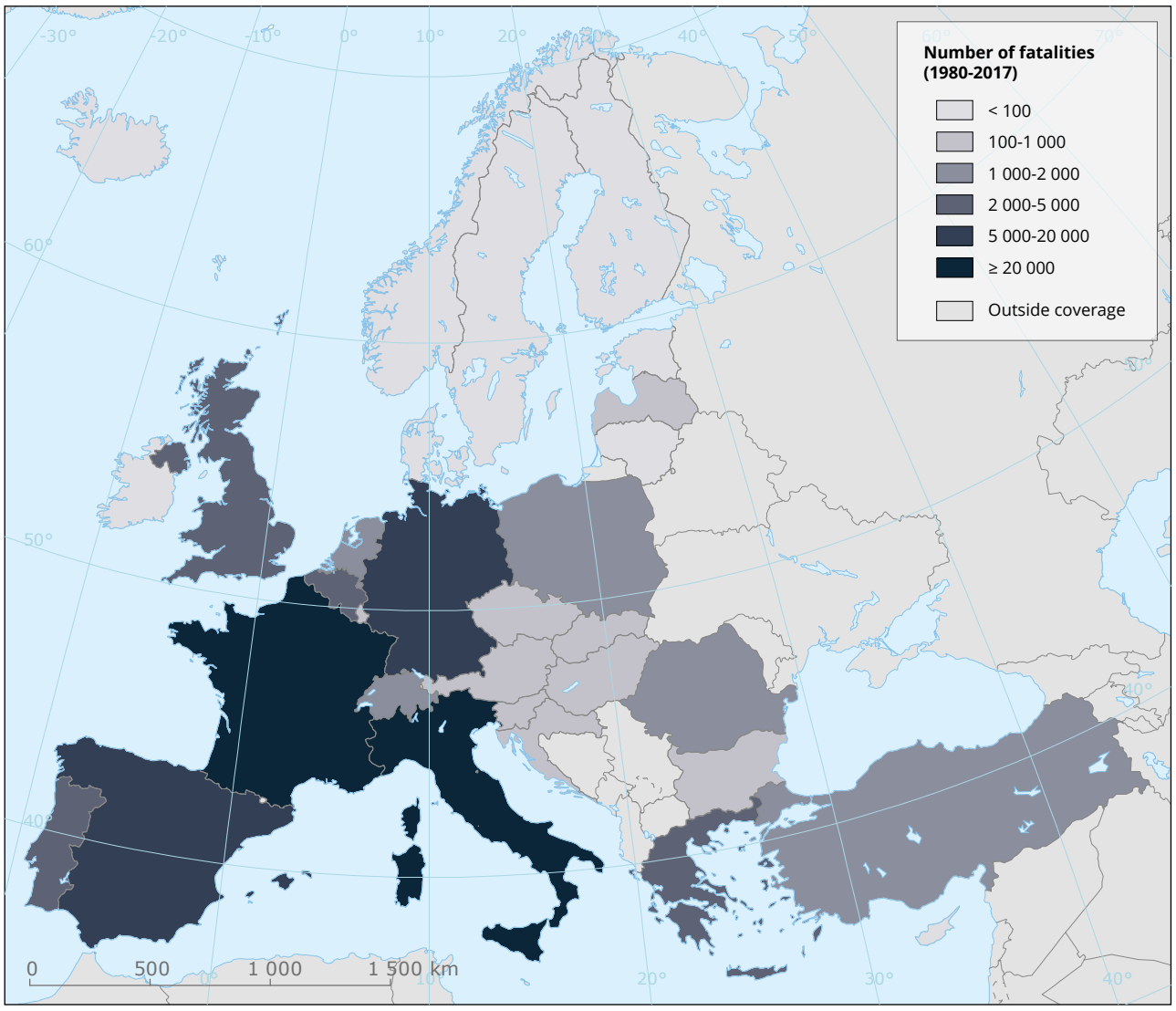


Figure 10. Fatalities in extreme weather and climate-related events, 1980-2017. Source: MunichRe/EEA[50]

[49] Idem.

[50] The European Environment Agency, Number of fatalities, 1980-2017. Available at https://www.eea.europa.eu/data-and-maps/figures/number-of-fatalities-1

As regards fatalities in disaster events caused by individuals or groups with malicious intent, the reported data reveals that 436 persons were killed in terrorist attacks perpetrated in the EU between 2006 and 2019. The majority of deaths from terrorism were caused by the mass-casualty attacks carried out in 2015 and 2016[51] *(Figure 11).*

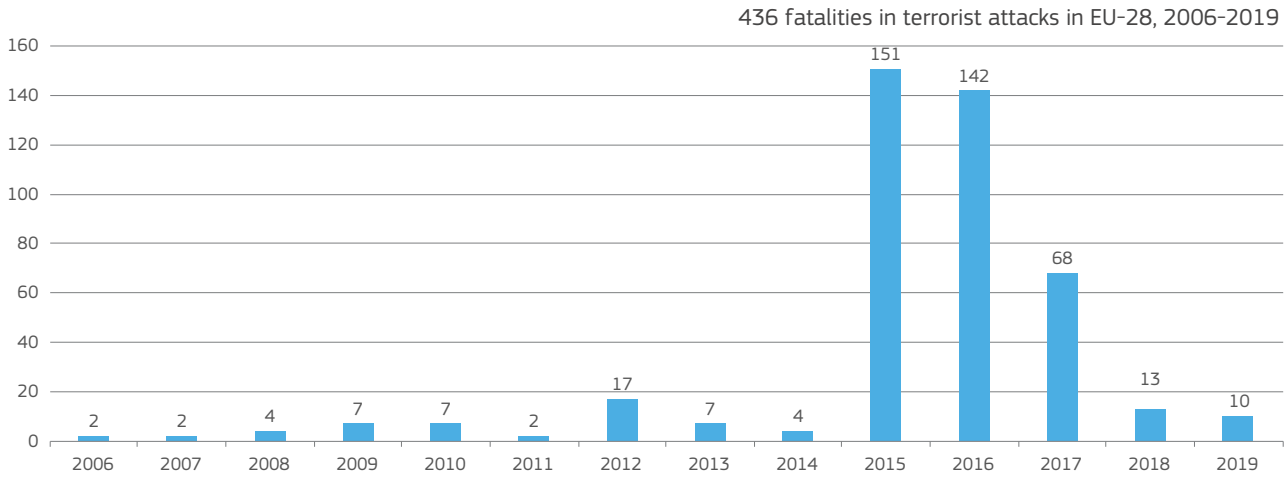


Figure 11. Fatalities in terrorist attacks in the EU-28, 2006-2019. Source: EUROPOL[52]

In terms of the economic impact of disasters, more systematic and comparable data is only available for weather-related and geophysical events.[53] Total economic losses from these types of events exceeded EUR 500 billion over the period 1980-2017. The largest share of all recorded losses was caused by storms and floods *(Figure 12).* Most of the damage, approximately 70%, was caused by relatively few (3%) high-impact events, such as the 2002 flood in central Europe or the 2016/2017 earthquakes in Italy. Although damage varies significantly from year to year and by geographical location, the general trend over time is of increasing losses from extreme weather events *(Figure 13).* Only a third of the losses incurred were insured *(Figure 14).*

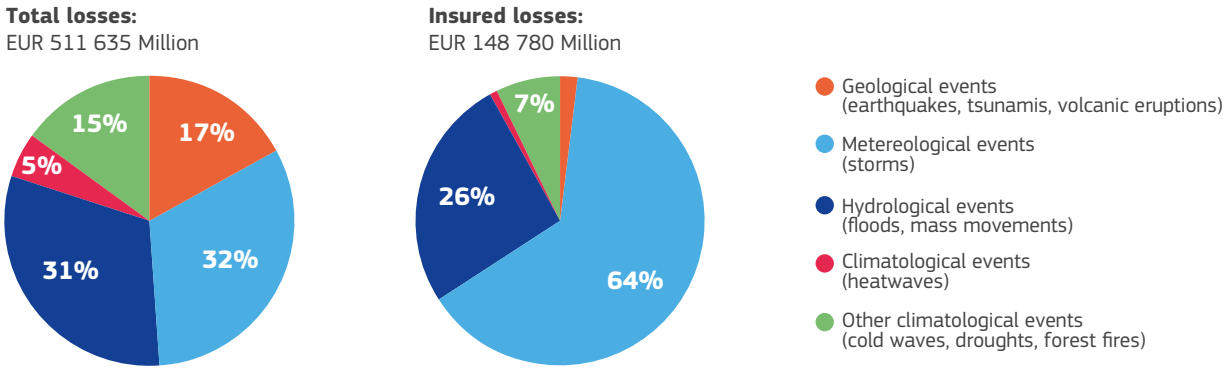


Figure 12. Economic losses from disasters caused by natural hazards, EU-28, 1980-2017. Source: MunichRe/EEA[54]

[51] EUROPOL, EU Terrorism Situation and Trend Reports 2007-2020. Available at https://www.europol.europa.eu/activities-services/main-reports?rt[0]=282

[52] Idem.

[53] The European Environmental Agency collects information on fatalities and economic losses from disasters caused by natural hazards. The data is provided by the NatCatSERVICE of the Munich Reinsurance Company. It covers geophysical events (earthquakes, tsunamis, and volcanic eruptions), meteorological events (storms), hydrological events (floods, mass movements), climatological events (cold waves, heatwaves, droughts, and forest fires). Available at https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2

[54] Idem.

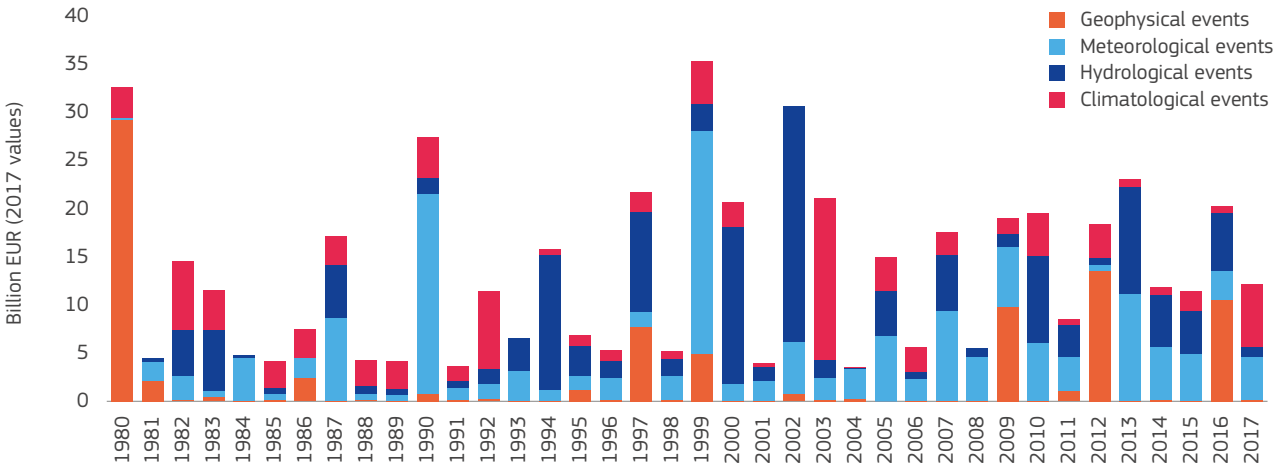


Figure 13. Economic losses from disasters caused by natural hazards, by year, EU-28, 1980-2017. Source: MunichRe/EEA[55]

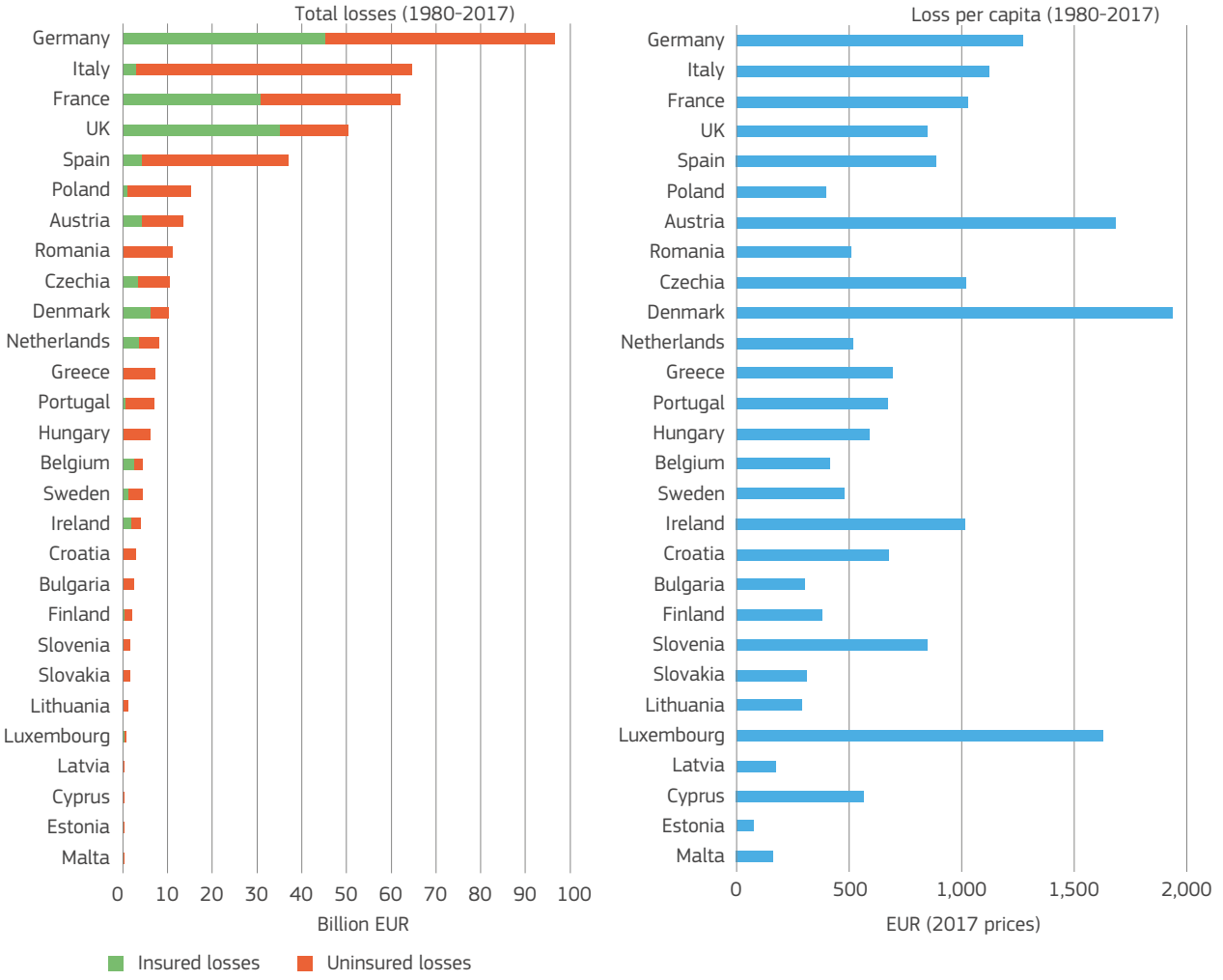


Figure 14. Impacts of extreme weather and climate-related events in the EU, 1980-2017[56]

[55] Idem.

[56] Idem.

Disasters often cause serious or even irreversible damage to the natural environment and to cultural heritage, but these impacts are more difficult to quantify in monetary terms and thus are not reflected in the statistics estimating losses. However, the recent adverse events in Europe that damaged natural ecosystems and cultural heritage have once again highlighted the importance of safeguarding these invaluable resources from disaster. For example, every year, wildfires destroy areas protected under the European Natura 2000 network[57] *(Figure 15)* or national protected sites, wiping out decades of achievements in preserving habitats, species and landscapes for future generations.[58]

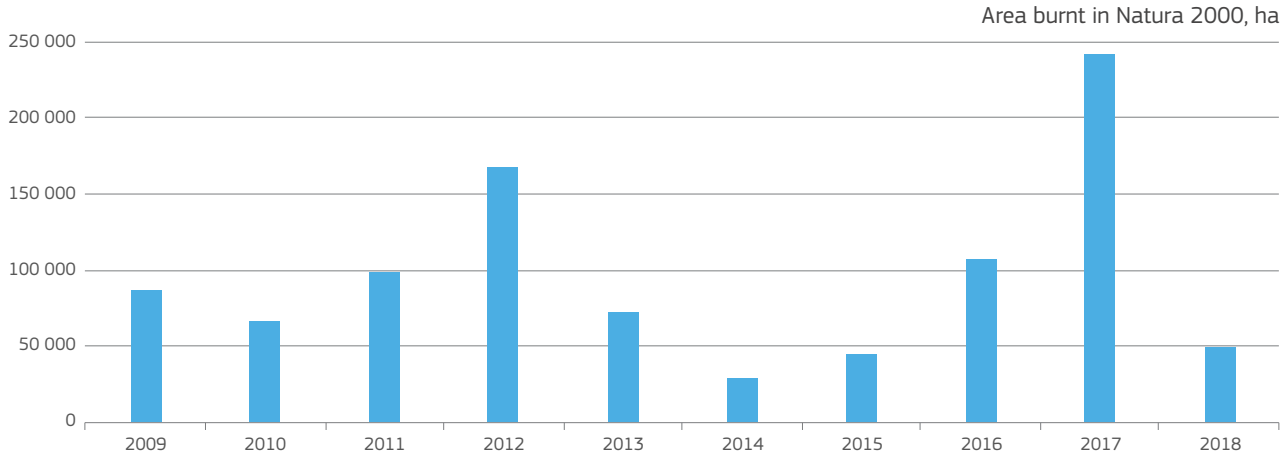


Figure 15. Area of land in Natura 2000 sites burnt, in hectares, 2009-2018. Source: Reports on Forest Fires in Europe, Middle East and North Africa 2009-2018[59]

Natural and man-made hazards also continue to put European cultural heritage under pressure and to compound conservation challenges *(see example in Box 3)*. Available evidence suggests that protecting cultural heritage from disasters still receives insufficient focus in risk management strategies and planning across the EU.[60] The recent European Court of Auditors' report on EU investment in cultural sites also recommended stepping up action to preserve heritage sites by identifying risks and planning mitigation measures.[61]

[57] The main goal of the Natura 2000 network is to safeguard Europe's most valuable and threatened species and habitats. For more information about Natura 2000, see https://ec.europa.eu/environment/nature/natura2000/index_en.htm

[58] The European Commission, Annual reports on Forest Fires in Europe, Middle East and North Africa 2009-2018. Available at https://effis.jrc.ec.europa.eu/reports-and-publications/annual-fire-reports/

[59] Idem.

[60] Safeguarding cultural heritage from natural and man-made disasters. A comparative analysis of risk management in the EU, 2018. Available at https://op.europa.eu/en/publication-detail/-/publication/8fe9ea60-4cea-11e8-be1d-01aa75ed71a1

[61] The European Court of Auditors, EU investments in cultural sites: a topic that deserves more focus and coordination. Special report, 2020. Available at https://www.eca.europa.eu/Lists/ECADocuments/SR20_08/SR_Cultural_investments_EN.pdf

Box 3. Cultural heritage and disasters: the 2019 floods in Venice

In November 2019, Venice and its lagoon, a UNESCO World Heritage site, saw the second worst flood in its recorded history. Due to high tides, heavy rain and sirocco winds, the water rose to 187 centimetres above sea level – the highest since the previous record level reached in 1966. This left over 85% of the city flooded and caused damage of at least EUR 1 billion, according to initial estimates.[62] Water harmed numerous historic artefacts and sites: museums, churches and palaces, including St Mark's square, St Mark's Basilica and the Doge's Palace. In the aftermath of the disaster, the World Heritage Committee asked Italy to submit an updated report on the state of conservation of this World Heritage site, with a view to considering recording it on the List of World Heritage in Danger, if the implemented mitigation measures and the adapted management system do not result in significant and measurable progress in the state of conservation of the site.[63] [64] [65]

In summary, although measures taken to address multiple disaster risks have played an important role in protecting the European public, the damage caused by disasters is increasing, challenging national and European response capacity and public budgets. In the past, based on available data, infectious diseases and heatwaves were the biggest 'killers', while storms, floods and earthquakes were the costliest natural hazards in terms of economic loss caused. The fact that most of the harm was caused by a few, relatively rare high-impact events highlights the importance of prevention and preparedness for these types of scenario.

It must be emphasised that, although the available data on past disasters provides useful insights, it should be taken with caution as it does not capture the full picture. We know more about certain types of impact and certain types of risk than about the others. We also know that available data overall tends to underestimate the scale of loss, at least for some hazards.[66] (See Chapter 4 for more

[62] Venezia, Brugnaro: "Danni inestimabili, almeno un miliardo", La Presse, 17 November 2019. Available at https://www.lapresse.it/politica/venezia_brugnaro_danni_inestimabili_almeno_un_miliardo_-2042386/video/2019-11-17/

[63] UNESCO, Decision No. 43 COM 7B.86. Venice and its Lagoon (Italy) (C 394). Available at https://whc.unesco.org/en/decisions/7524

[64] UNESCO closely follows tides and flooding in Venice World Heritage Site, 13 November 2019. Available at https://whc.unesco.org/en/news/2055

[65] UNESCO closely monitoring ongoing threats to Venice World Heritage Site, 14 October 2019. Available at https://whc.unesco.org/en/news/2043

[66] One example is loss caused by wildfires. See San-Miguel-Ayanz, J. and Camia, A. 2010. Forest Fires, in EEA Technical report on mapping the impacts of natural hazards and technological accidents in Europe, ISSN 1725-2237.

details on data-related challenges). Moreover, past experience cannot be the (only) indication of what lies ahead in terms of disaster risk as there are powerful forces at play shaping the nature of hazards, our exposure to them and our vulnerability. The following section takes a closer look at some of the key drivers behind changes to the risk landscape that shed light both on historic trends and projections for future.

3.2. Risk drivers

Disaster risk is a dynamic phenomenon. It evolves over time and location in step with changes to hazard characteristics, exposure, the vulnerability of people and assets and/or our capacity to cope. For example, climate change is altering the patterns of extreme weather events, technological developments are changing the nature of man-made threats, urbanisation is one of the factors behind the growing exposure to hazards, and both environmental degradation and ageing societies decrease our resilience. The remainder of the section focuses on several of these mega trends, namely climate change, urbanisation, environmental degradation, the changing security paradigm and technological developments, with a special focus on their implications for disaster risk in Europe. Though these risk drivers are discussed individually, they should not be seen in isolation as they interact with each other, amplifying existing risk or resulting in the emergence of new risks.

Box 4. New and emerging risks

'Emerging risk' appears in the risk landscape due to changes in one or several of its components: hazard, vulnerability and/or exposure. New or emerging risks can manifest themselves due to a new type of hazard (new process or phenomenon not considered before), to an increase in vulnerability and/or exposure, or to a decrease in coping capacity. Emerging risks have a high degree of uncertainty in terms of the probability of occurrence and the potential damage they can cause.

3.2.1. Climate change

The average global temperature is now around 1°C higher than in the pre-industrial era (1850-1899). The past five years (2015-2019) were the hottest since records began. July 2019 was the hottest month ever recorded. Greenhouse gas emissions worldwide continue to rise, despite the target set under the Paris Agreement on Climate Change[67] to keep global warming well below 2°C and to take action to limit the temperature increase to 1.5 °C above pre-industrial levels. Recent projections estimate global warming in a range of 2.9-3.8°C by 2100 under current climate policies, and around 2.7°C if all countries meet the nationally determined contribution (NDC) targets set under the Paris Agreement *(Figure 16)*.

[67] Adoption of the Paris Agreement FCCC/CP/2015/L.9 (UNFCC, 2015).

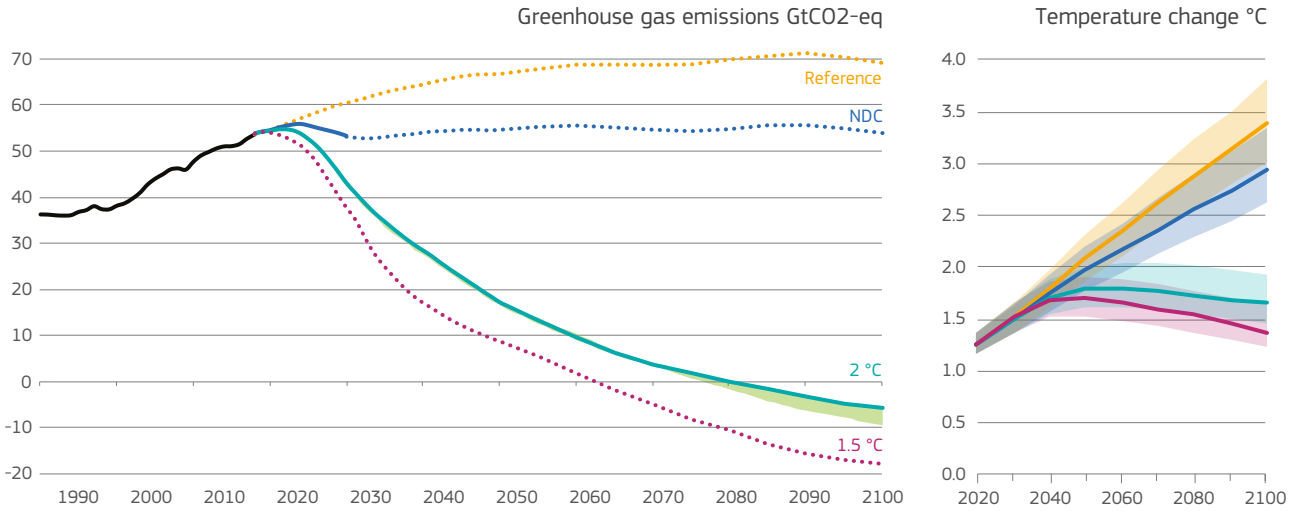


Figure 16. Global GHG emissions and global mean temperature change. Source: JRC[68]

The global temperature averages mask even more extreme regional impacts. An average increase of 3°C or 4°C globally means temperature increases of over 5°C or 6°C in some regions. In Europe, the temperature has already increased by more than the global average. The average annual temperature of the European land area over the last decade (2009–2018) was between 1.6°C and 1.7°C above the pre-industrial level.[69]

Global temperature changes are already having consequences in terms of melting polar ice caps, sea level rise and changing weather patterns[70] *(Box 5).* The 2020 State of the European Environment report concludes that in Europe, climate change has increased the occurrence of weather extremes.[71] Recent research attributes the increased frequency and intensity of the heatwaves seen in Europe in 2003, 2010, 2015, 2017, 2018 and 2019 to human-induced climate change.[72] Although not all weather extremes can be attributed to global warming, there is growing consensus that greenhouse gases emissions caused by human activities are influencing the climate and the Earth's temperature.

[68] Keramidas, K., Diaz Vazquez, A., Weitzel, M., Vandyck, T., Tamba, M., Tchung-Ming, S., Soria-Ramirez, A., Krause, J., Van Dingenen, R., Chai, Q., Fu, S. and Wen, X. Global Energy and Climate Outlook 2019: Electrification for the low carbon transition, Luxembourg: Publications Office of the European Union, 2020, ISBN 978-92-76-15065-7, doi:10.2760/350805, JRC119619.

[69] The European Environment Agency. Global and European temperature. Available at https://www.eea.europa.eu/data-and-maps/indicators/global-and-european-temperature-9/assessment

[70] Intergovernmental Panel on Climate Change. 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

[71] The European Environment Agency, The European environment – state and outlook 2020 (SOER2020), Luxembourg, Publications Office of the European Union, 2019. ISBN: 978-92-9480-090-9. Available at https://www.eea.europa.eu/publications/soer-2020

[72] World Weather Attribution, Human contribution to the record-breaking July 2019 heatwave in Western Europe, 2 August 2019. Available at https://www.worldweatherattribution.org/human-contribution-to-the-record-breaking-july-2019-heat-wave-in-western-europe/

Box 5. Climate change and its impacts: insights from the IPCC special reports

The Special Report on global warming of 1.5°C above pre-industrial levels[73], published by the Intergovernmental Panel on Climate Change (IPCC) in 2018, finds that we are already seeing the consequences of 1°C of global warming through more extreme weather, rising sea levels and diminishing Arctic sea ice, among other changes. Warming of 2°C or higher increases the risk of long-lasting or irreversible changes, including the loss of some ecosystems and negative impacts on human health and well-being. Limiting the temperature increase to 1.5°C would significantly reduce the most adverse consequences of climate change. Although there is a significant gap between the level of current action and what would be required to keep global temperature increase below 2°C, let alone 1.5°C, the report concludes that limiting global warming to 1.5°C is doable, provided we act now and use every tool at our disposal.

In August 2019, the IPCC published another **Special Report on Climate Change and Land**.[74] This report highlights that keeping global warming to well below 2ºC can be achieved only by reducing greenhouse gas emissions from all sectors, including land and food. The way we are currently using land is exacerbating climate change. This in turn is leading to warmer land temperatures, which have increased faster than the global average. These developments increase the risks of water scarcity, wildfires, permafrost degradation and food system instability. On a more positive note, land across the world is still removing more emissions than it releases. There is also potential to reduce emissions from the land sector by managing land resources more sustainably and by changing the way we produce and consume food.

The **Special Report on the Ocean and Cryosphere in a Changing Climate**[75] published in September 2019 presents the latest scientific evidence showing that the ocean is now warmer, more acidic and less productive. Glaciers, snow, ice and permafrost are declining, and the trend is projected to continue. Melting glaciers and ice sheets together with expansion of the warmer ocean are accelerating sea level rise, while coastal extreme events are becoming more severe. The changes observed are affecting ecosystems and people's lives, especially those in high mountain regions, coastal zones, and the Arctic. The report warns that ice-melt or the thawing of permafrost involve thresholds that, if passed, could lead to abrupt, nonlinear responses to ongoing climate warming.

All the above reports urge countries worldwide to reduce greenhouse gas emissions to limit global warming, set out options for adaptation and make the case for building resilience.

Our ability to detect whether the extreme events we experience are linked to climate change is improving with better understanding of the climate system, improved data and higher computing power. Despite considerable progress achieved in recent years, the science of attributing the occurrence and intensity of individual disaster events to climate change is still in its infancy. Further work is needed to, on the one hand, ensure the robustness of results to inform policy making and, on the other hand, broaden the scope of the analysis in terms of geography, spectrum and impacts of disasters covered. What is however undisputed is that, in the absence of decisive climate action, global warming will continue, with dire consequences for people and their assets, as well as for ecosystems.

In the EU, reported economic losses from weather extremes are on average already EUR 12 billion per year.[76] Looking forward, a series of PESETA research projects (PESETA-Projection of economic impacts of climate change in sectors of the European Union based on bottom-up analysis) led by the Joint Research Centre of the European Commission (JRC) focused on improving understanding of future implications and the costs of climate change specifically for the EU. The most recent PESETA IV study

[73] IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

[74] IPCC, 2019: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press.

[75] IPCC, 2019: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press.

[76] Average for 1980-2017, expressed in 2017 prices.

published in 2020[77] concludes that all regions in Europe will be affected by climate change, though to a varying degree *(Box 6)*. Northern Europe is expected to experience decreased ice cover and higher temperatures, in particular in the Arctic, as well as more rainfall and floods. However, climate change impacts will be felt particularly strongly in southern regions of Europe, where an increase in extreme heat, water scarcity, drought, wildfires and agriculture losses is forecast.

Box 6. Projected climate change impacts in Europe: PESETA IV research results

The 2020 PESETA IV report estimates that, in a scenario where global temperature rises 3°C or more above pre-industrial levels and without adaptation action, the EU could face the following impacts:

- **Ecological domains** would shift northwards, resulting in severe changes of the prevailing domains in southern Europe and Boreal areas and the encroachment of the Tropical domain in Europe. The alpine tundra would contract by 84% and practically disappear in the Pyrenees. The natural climatic tree line would shift vertically up by up to 8 m/year.
- Each year nearly 300 million people in the EU and the UK would be exposed to deadly **heatwaves**, resulting in a 30-fold rise in deaths from extreme heat (90 000 annual excess deaths compared to around 3 000 each year today).
- **Wildfires and pest outbreaks** would become more frequent and severe, increasing biomass loss and carbon release. An additional 15 million Europeans living in the proximity of wildland would be exposed to high-to-extreme fire danger for at least 10 days/year.[78]
- The availability of **water resources** would fall by up to 40% in southern regions of Europe. During the summer, most people and businesses in these regions would face water scarcity. **Droughts** would happen more frequently in most of southern, but also western Europe and increasingly affect agriculture, energy and water supply sectors. Total drought losses for the EU and the UK would increase to nearly EUR 45 billion/year with 3°C warming in 2100 compared to EUR 9 billion/year at present.
- Almost half a million people in the EU and the UK would be exposed to **river flooding** each year, nearly three times the current number. River flood losses would rise six-fold in magnitude, reaching nearly EUR 50 billion/year under a 3°C warming scenario in 2100.
- **Coastal flood** losses in the EU and the UK would grow by two orders of magnitude and climb to EUR 250 billion/year in 2100, while 2.2 million people would be exposed annually to coastal flooding, compared to 100 000 at present.

[77] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

[78] Statistics based on available data for countries in the EU, UK and EFTA, candidate countries and potential candidates.

Box 6. Projected climate change impacts in Europe: PESETA IV research results (continued)

- If 3°C global warming occurred in today's economy, **annual welfare loss** in the EU and the UK could reach approximately 0.5% of EU GDP, including only a limited set of climate impacts (river and coastal flooding, agriculture, droughts, energy supply, and windstorms). Furthermore, mortality from extreme temperatures would also cause significant economic loss. Using the value of statistical life as a measure, the impact could be in the range of EUR 122 billion, compared to today. Southern Europe is estimated to be more severely affected, in particular due to impacts on coastal areas, the agriculture sector, and drought. Including heat-related mortality in the loss estimates makes the regional differences even more striking, with southern and central Europe hit the hardest. At aggregate level (EU and UK), river and coastal floods account for the highest share of welfare loss, particularly in northern and central EU regions. Changes in drought impacts could increase welfare in northern Europe, but reduce welfare in southern EU regions.
- Europe is also affected by climate impacts occurring outside its territory. In the interconnected global economy, spillover effects can be felt through global trade, supply chains, geopolitics and security, migration or the spread of disease. The PESETA IV study estimated that **international spillover effects** could increase internal EU welfare loss by approximately 20%.[79]

The magnitude of future weather-related risks and impacts will depend on a variety of factors, including levels of development and vulnerability, and on the choices and implementation of adaptation and mitigation measures. The way we live – the environmental, socioeconomic, political and technological context – will play a role and may contribute to our vulnerability to the effects of climate change. We can reduce the future risks and impacts by scaling up and accelerating climate mitigation, and by taking both incremental and transformational adaptation action.

When estimating climate change development and impacts, there are important factors about which we still have limited knowledge: tipping points. Tipping points are thresholds that, if crossed, could send the Earth into a spiral of runaway climate change. For instance, the thawing of Arctic permafrost due to rising temperatures could release vast amounts of greenhouse gases that it stores into the atmosphere, further exacerbating global warming. Another example of dangerous events is the unprecedented Arctic wildfires seen in June 2019, which released the same amount of CO_2 into the atmosphere as the total of Arctic wildfires in the same month from 2010 to 2018.[80] Such fires could trigger unpredictable changes in the Arctic or the climate system. Uncertainty around the probability and effects of the tipping points is high, but science is making rapid progress in identifying early warning signs. The next IPCC assessment report is expected to shed more light on this issue. The unpredictability and unknowns related to tipping points do not justify inaction; the potential impacts are too dangerous. Work on disaster risk management, climate change mitigation and adaptation and resilience building should specify what is needed to address these events and make the case for the right policies, action and investment decisions.

3.2.2. Urbanisation[81]

Urban areas are where the majority of the population now reside: cities, towns and suburbs are home to three quarters of Europeans.[82] Future projections suggest that by 2050, the overall level of urbanisation in Europe will exceed 80%.[83] Urban areas are also centres of economic activity and growth. For example, in 2014, metropolitan areas generated 47% of the EU's GDP.[84] Due to the high concentration of population, infrastructure, business

[79] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

[80] World Meteorological Organisation. Unprecedented wildfires in the Arctic, 12 July 2019. Available at https://public.wmo.int/en/media/news/unprecedented-wildfires-arctic

[81] Urbanisation in this document is understood as the movement of people to urban areas and/or the increase of urban areas, population and processes.

[82] European Union and United Nations Human Settlements Programme (UN-Habitat). The State of European Cities 2016. Cities leading the way to a better future, ISBN Number: (Volume) 978-92-79-64260-9 | doi:10.2776/770065 Luxembourg: Publications Office of the European Union, 2016.

[83] Sustainable development in the European Union, Monitoring report on progress towards the SDGs in an EU context, 2019 edition. ISBN 978-92-76-00777-7 doi:10.2785/44964 KS-02-19-165-EN-N.

[84] EUROSTAT, Urban Europe – statistics on cities, towns and suburbs — patterns of urban and city developments. ISBN: 978-92-79-60139-2; doi: 10.2785/91120; Cat. No: KS-01-16-691-EN-N.

and cultural heritage, urban areas often take the brunt of damages and losses when a disaster event hits.

The dynamics and patterns of urbanisation are important determinants of whether and how disaster risk is affected. In Europe, the urban population is increasing, but at a slower pace than in other regions of the world. However, the built-up area is expanding faster than the population is growing (*Figure 17*). Urban and land-use planning in EU Member States is a highly regulated field, providing the framework for integrated urban development. A range of EU policy initiatives and legislation also promote balanced land use, sustainability and the safety of cities. Notwithstanding this, urban growth has not been without challenges and negative side effects in terms of disaster risk.

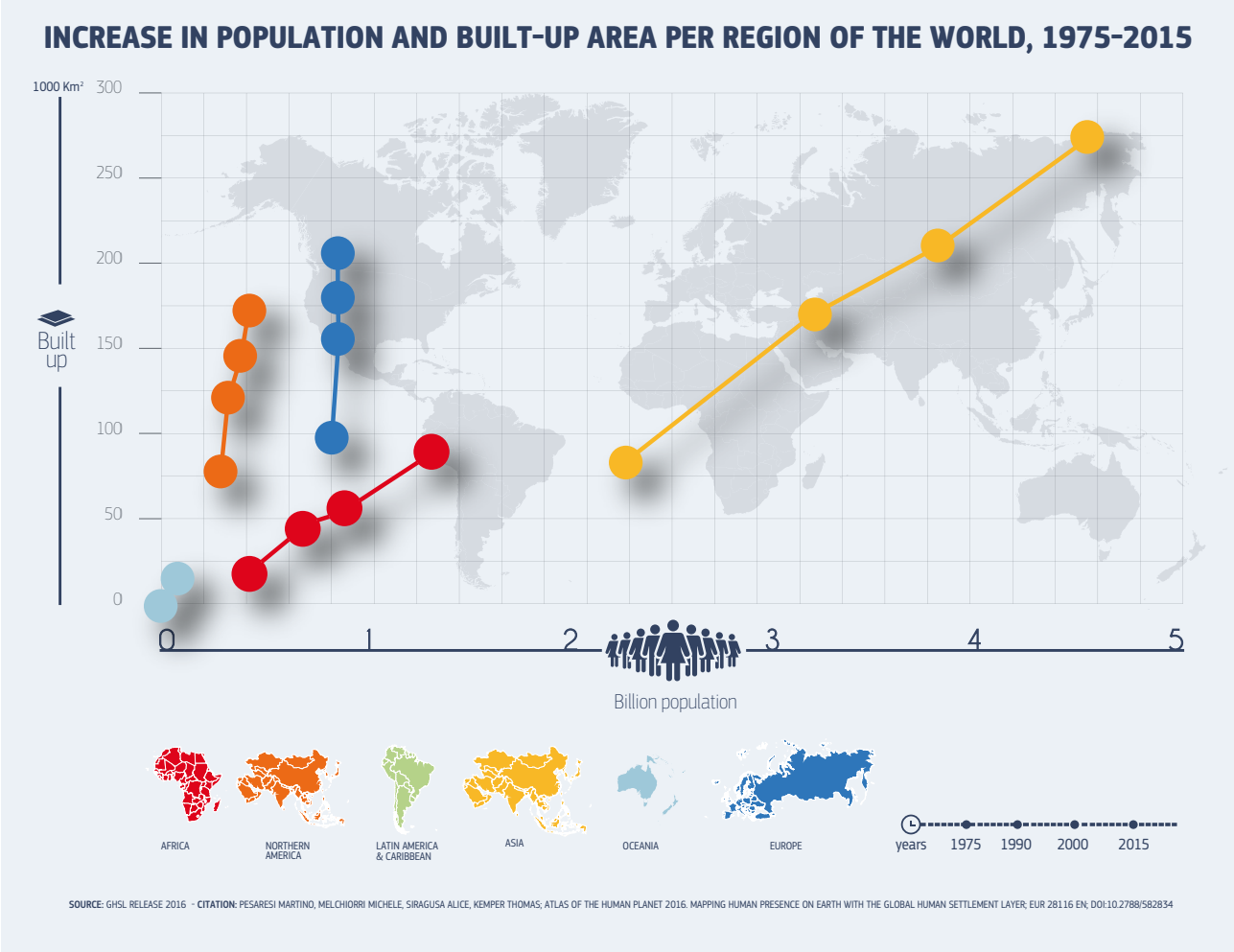


Figure 17. Change in population and built-up areas, 1975-2015 per region of the world. Source: JRC[85]

[85] Mapping human presence on Earth, The Global Human Settlements Layer. Key messages from the Human Planet Atlas. Available at: https://ec.europa.eu/jrc/sites/jrcsh/files/jrc-ghsl-infographics-key_messages.pdf

In Europe, the surface area of cities and the share of built-up areas have been increasing, in particular in the main metropolitan and coastal zones.[86] [87] [88] Geographical expansion has brought people and assets closer to hazards. Urbanisation along the European coast, boosted by increasing demand for leisure, has exposed more people and assets to coastal flooding. Simultaneously, sea levels and extreme high coastal water levels have been rising. An interplay between these changes is likely to lead to major increases in losses from coastal flooding in the future, unless measures are taken.[89] Another example is the increasing risk of wildfires with human casualties and damage to properties resulting from an urban sprawl into forested areas. The encroachment of urban areas on industrial sites is yet another concern from a disaster risk perspective that has gained renewed attention after recent chemical accidents in France (Rouen, September 2019) and Spain (Tarragona, January 2020).

Growing cities have not been immune to the urban sprawl phenomenon associated with harmful effects. Sprawling cities consume larger amounts of land, demand more energy and transport, and emit higher amounts of greenhouse gases compared to more compact settlements. As the built environment expands in a sprawling manner, it fragments landscapes, leading to the deterioration of biodiversity and ecosystem services.[90] [91] [92] This aggravates the impacts of floods, droughts and heatwaves. Despite efforts to address the problem, urban sprawl has been increasing in all European countries.[93] *Figure 18* visualises the pattern of net land take across Europe, which is one of the proxies of urban sprawl, reflecting the change in the area of agricultural, forest and other semi-natural land taken for urban and other artificial land development.[94]

[86] The Joint Research Centre of the European Commission, European Territorial Trends, Facts and Prospects for Cities and Regions Ed. 2017. Science for Policy report. ISBN 978-92-79-73428-1 ISSN 1831-9424 doi:10.2760/148283.

[87] The European Environment Agency, Land take in Europe. Available at https://www.eea.europa.eu/data-and-maps/indicators/land-take-3

[88] The European Environment Agency. The changing faces of Europe's coastal areas. EEA Report No 6/2006 – Available at https://www.eea.europa.eu/publications/eea_report_2006_6;Balancing the future of Europe's coasts - knowledge base for integrated management. EEA Report No 12/2013 – Available at https://www.eea.europa.eu/publications/balancing-the-future-of-europes

[89] The European Environment Agency. Global and European sea-level rise. Available at https://www.eea.europa.eu/data-and-maps/indicators/sea-level-rise-6/assessment

[90] Ecosystem services are the benefits that people obtain from ecosystems. In other words, ecosystem services are the direct and indirect contributions of ecosystems to human wellbeing. These services include provisioning, regulating, cultural and supporting services on which societies and economies depend, including food and water provision, climate regulation, flood control, air and water purification, erosion control, etc. Source: European Commission. Mapping and Assessment of Ecosystems and their Services. April 2013. Available at doi: 10.2779/12398

[91] De la Fuente, B., Bertzky B., Delli D., et al. (2020). Built-up areas within and around protected areas: Global patterns and 40-year trends. Global Ecology and Conservation, 24, e01291. Available at https://doi.org/10.1016/j.gecco.2020.e01291

[92] Ward, M., Saura, S., Williams, B. et al. (2020). Just ten percent of the global terrestrial protected area network is structurally connected via intact land. Nature Communications 11, 4563. Available at https://doi.org/10.1038/s41467-020-18457-x

[93] The European Environment Agency. Urban sprawl in Europe. Joint EEA-FOEN report No. 11/2016. Luxembourg, Publications Office of the European Union, 2016. ISBN 978-92-9213-738-0. ISSN 1977-8449. doi:10.2800/143470

[94] The European Environment Agency, Land take in Europe. Available at https://www.eea.europa.eu/data-and-maps/indicators/land-take-3

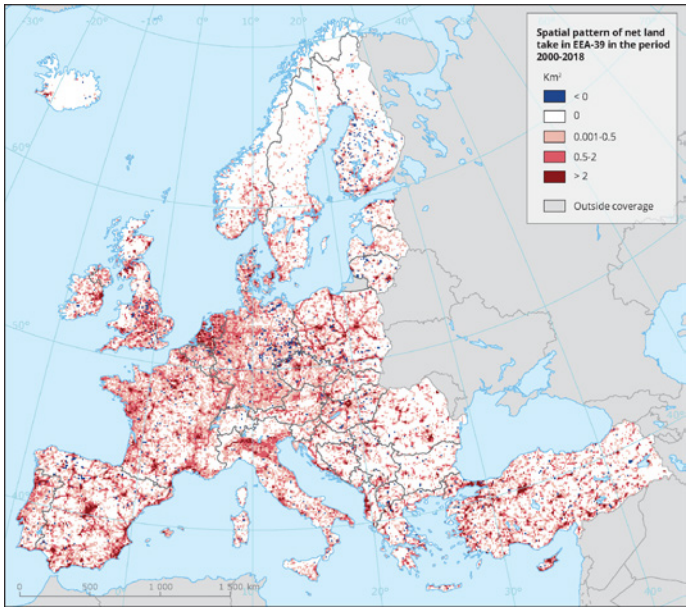
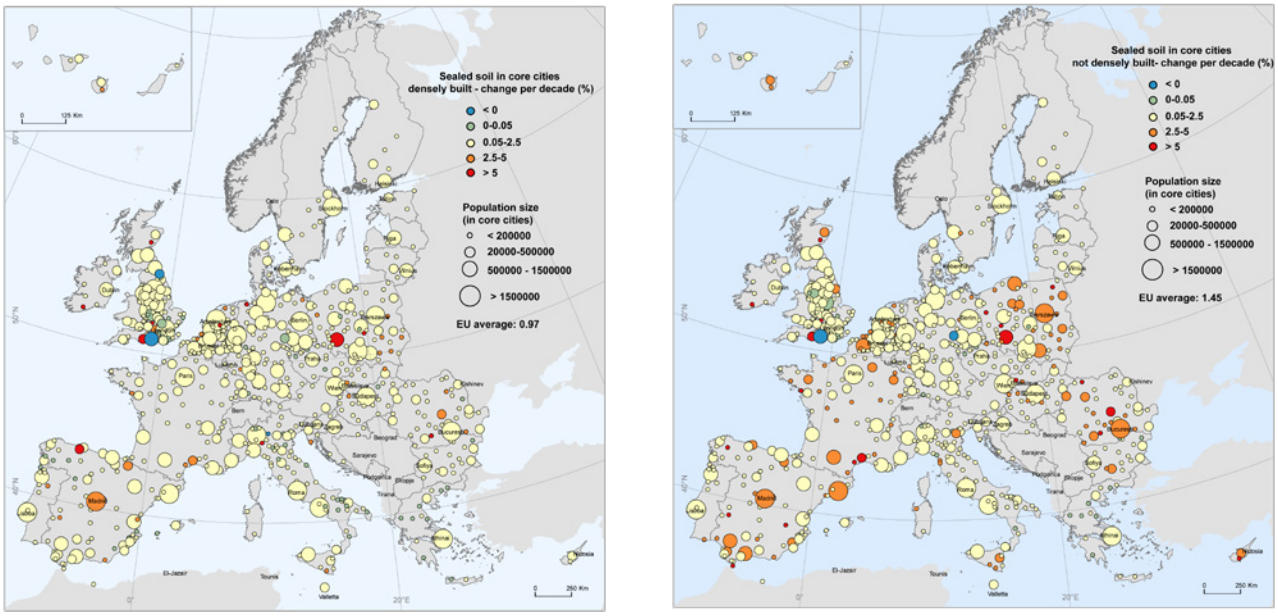


Figure 18. Pattern of net land take in Europe between 2000-2018 (km^2). Source: EEA[95]



(a) *(b)*

Figure 19. Change per decade in the share of sealed soil in core cities, (a) densely built and (b) not densely built. Source: JRC[96]

[95] The European Environment Agency, Spatial pattern of net land take in EEA-39 in the period 2000-2018. Available at https://www.eea.europa.eu/data-and-maps/figures/spatial-pattern-of-net-land

[96] Idem.

Recent JRC research shows how urban growth in Europe has led to increasing soil sealing (Figure 20). The share of sealed soil has risen in areas that are already densely built (estimated at 0.97% per decade), but even more so in the less densely built areas of the cities (estimated at 1.45% per decade), where there are still opportunities for alternative solutions for territorial development.[97]

Soil sealing means reduced capacity to mitigate floods. Almost half (46%) of Europe's urban area now has a low capacity to mitigate floods[98] (*Figure 20).* Impervious surfaces not only prevent rain from being absorbed into the ground, they also inhibit the replenishment of groundwater supplies. This exacerbates water scarcity problems, especially where water consumption is increasing due to a growing population and economic activities, while drought episodes are becoming more common.[99]

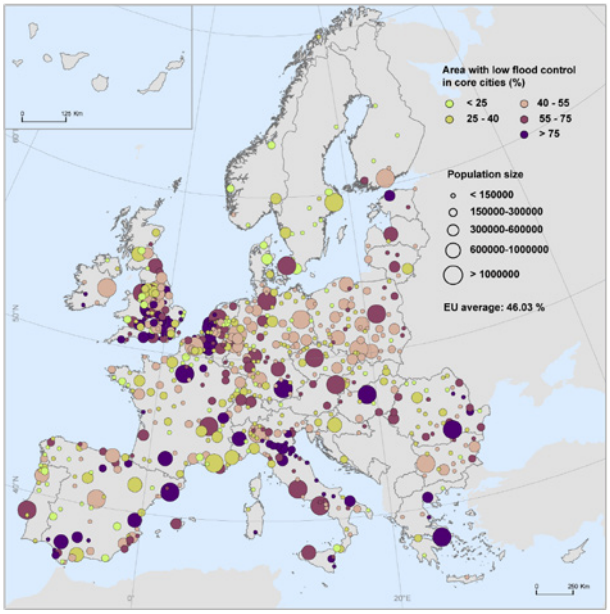


Figure 20. Surface area with a low capacity to control flooding in cities. Source: JRC[100]

During heatwaves, the built environment and impervious soils create favourable conditions for the 'urban heat island' effect – a microclimatic phenomenon whereby urban settings experience higher temperatures than their rural surroundings. This is one of the major concerns for urban authorities across Europe, given the detrimental effects on human health and the projected increase in the frequency and intensity of heatwaves *(Box 7).*

97 Maes, J., Teller, A., Erhard, M., Condé, S., Vallecillo, S., Barredo, J., Paracchini, M.L., Abdul Malak, D., Trombetti, M., Vigiak, O., Zulian, G., Addamo, A., Grizzetti, B., Somma, F., Hagyo, A., Vogt, P., Polce, C., Jones, A., Marin, A.I., Ivits, E., Mauri, A., Rega, C., Czúcz, B., Ceccherini, G., Pisoni, E., Ceglar, A., De Palma, P., Cerrani, I., Meroni, M., Caudullo, G., Lugato, E., Vogt, J.V., Spinoni, J., Cammalleri, C., Bastrup-Birk, A., San Miguel, J., San Román, S., Petersen, J., Kristensen, P., Christiansen, T., Zal, N., de Roo, A., Cardoso, A.C., Pistocchi, A., Del Barrio Alvarellos, I., Tsiamis, K., Gervasini, E., Deriu, I., La Notte, A., Abad Viñas, R., Vizzarri, M., Camia, A., Robert, N., Kakoulaki, G., Garcia Bendito, E., Panagos, P., Ballabio, C., Scarpa, S., Montanarella, L., Orgiazzi, A., Fernandez Ugalde, O., Santos-Martín, F., Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment. – 15 October 2020 – Available at https://publications.jrc.ec.europa.eu/repository/handle/JRC120383.

98 Maes J, Zulian G, Günther S, Thijssen M, Raynal J, Enhancing Resilience Of Urban Ecosystems through Green Infrastructure. Final Report, EUR 29630 EN; Publications Office of the European Union, Luxembourg, 2019, doi:10.2760/689989, JRC115375.

99 The European Environment Agency, Water in the city. Available at https://www.eea.europa.eu/articles/water-in-the-city

100 Maes J, Zulian G, Günther S, Thijssen M, Raynal J, Enhancing Resilience Of Urban Ecosystems through Green Infrastructure. Final Report, EUR 29630 EN; Publications Office of the European Union, Luxembourg, 2019, doi:10.2760/689989, JRC115375.

Box 7. Urban heat islands

Heat is one of the deadliest natural hazards. In cities, heatwaves pose particular dangers because their impacts are magnified by the 'urban heat island effect'. This occurs because asphalt and concrete absorb and re-radiate heat much more effectively than the natural environment. City traffic, air-conditioning and industrial activities further increase temperatures as they generate and emit heat. Due to city geometry and the limited availability of open green and blue zones, all this heat is trapped in urban canyons between tall buildings. Building density and the size of a city influence the intensity of the heat island effect.

Urban heat islands are associated not only with elevated temperatures, but also with higher air pollution levels. Ground level ozone, a hazardous air pollutant, is produced when other pollutants react in sunlight and stagnant air. High temperatures combined with air pollution levels have negative impacts on human health, leading to exhaustion, respiratory difficulties, heat stroke, stress on the cardiovascular system and premature death. The most vulnerable groups of the population include the elderly, children, people with health conditions and low-income residents living in poorer housing conditions. Although extreme heat is the biggest threat to health, it also impacts infrastructure and can disrupt the provision of vital services.

The heatwaves that have hit Europe in recent years have demonstrated the challenges that urban areas are facing in coping with scorching temperatures. Several years in a row, cities from north to south have broken new temperature records, including, for example, Helsinki (33.2°C in 2019), Paris (42.6°C in 2019) and Cordoba (46.9ºC in 2017). Hundreds of heat-induced deaths were reported during episodes of unusually high temperatures.[101] Extreme heat has also triggered disruptions in public transport, caused electricity blackouts and led to the temporary shutdown of nuclear reactors.[102] [103] [104] On a more positive note, in recent years, national, regional and local authorities have become much better prepared for heatwaves and have dedicated action plans, improved early warning systems and other life-saving measures, unlike in 2003, when the heatwave killed tens of thousands of Europeans.[105]

Future projections suggest that extreme heat is an issue that cities all across Europe will need to tackle. Although southern cities are forecast to see the largest increase in the number of heatwave days, central European cities will experience the highest increases in temperature. This is a concern given that in these areas, both the infrastructure and the population are generally less adapted to extreme heat. [106]

The design and characteristics of urban fabric – the built and the "green" environment – are important determinants of a city's resilience or vulnerability to hazardous events. In European cities, ageing building stock and infrastructure pose significant challenges. The size of the built-up area in the EU is about 25 billion square metres, of which about 10 billion were built before the 1960s. Buildings built more than half a century ago often do not meet evolving needs or standards for resilience. One major concern is earthquake resistance. JRC analysis shows that most buildings in the seismic-prone regions of Europe were designed without making provisions for earthquake resistance or following moderate-level seismic codes.[107] [108] Another issue is the resilience of infrastructure to withstand a changing climate – its ability to cope with the impacts of intensifying extreme weather events,

[101] For example, in France: https://solidarites-sante.gouv.fr/actualites/presse/communiques-de-presse/article/impact-sanitaire-modere-des-canicules-de-l-ete-2019-sur-les-chiffres-de-la; in the Netherlands: https://www.reuters.com/article/us-weather-netherlands/heatwave-caused-nearly-400-more-deaths-in-netherlands-stats-agency-idUSKCN1UZ0GA?il=0

[102] Europe swelters as heatwave smashes June records, Financial Times, 28 June 2019. Available at https://www.ft.com/content/76f3c5f2-99ad-11e9-9573-ee5cbb98ed36

[103] Faced with increasing heat waves frequency, European cities need to adapt, Euronews, Updated 22 November 2019. Available at https://www.euronews.com/2019/09/23/faced-with-increasing-heat-waves-frequency-european-cities-need-to-adapt

[104] Jon Henley (The Guardian). Climate crisis blamed as temperature records broken in three nations, The Guardian, 25 July 2019. Available at https://www.theguardian.com/world/2019/jul/24/summers-second-heatwave-set-to-break-records-across-europe

[105] Vautard R., Boucher O., van Oldenborgh G.J., Otto F., Haustein K., Vogel M.M., Seneviratne S.I., Soubeyroux J.M., Schneider M., Drouin A., Ribes A., Kreienkamp F., Stott P., van Aalst M. and Red Cross Red Crescent Climate Centre. Human contribution to the record-breaking July 2019 heatwave in Western Europe – Available at https://www.worldweatherattribution.org/wp-content/uploads/July2019_VF.pdf

[106] Selma B Guerreiro et al. Future heat-waves, droughts and floods in 571 European cities. 2018 Environ. Res. Lett. 13 034009 – Available at https://iopscience.iop.org/article/10.1088/1748-9326/aaaad3/meta

[107] The Joint Research Centre of the European Commission. Building stock inventory to assess seismic vulnerability across Europe. JRC technical reports, 2018, Publications Office of the European Union. ISBN: 978-92-79-86707-1 doi: 10.2760/530683.

[108] Tsionis G, Sousa ML, Palermo V, Maio R; Framework for resilience analysis of EU buildings, EUR 29053 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79- 77703-5, doi:10.2760/923762, PUBSY No. 110165.

especially in areas where they were not common in the past. This is also an issue for hazardous industry, which is often located in urban areas and which is seeing an increasing risk of accidents with toxic or radioactive releases, fires and explosions (called 'Natech' accidents) due to climate change.[109]

Green infrastructure,[110] green-grey hybrid infrastructure and nature-based solutions play an important role in mitigating weather-related disaster risks. Overall, European cities perform relatively well in terms of the share of green infrastructure. The JRC study of nearly 700 urban areas in the EU found that, on average, 40% of their surface was covered with green spaces. However, this percentage varies widely across EU cities, as does the distribution of green spaces within a city, and residents' access to it. Moreover, as the population grows, urban planners face increasingly difficult trade-offs: how to contain cities within their boundaries, avoid city sprawl, while at the same time maintaining or enhancing green spaces.[111] Compensating for land take and the loss of vegetation in urban areas is fundamental in order to avoid the negative effects of abrupt changes that characterised urban green infrastructure in European cities over the last 20 years.[112] This message features strongly in the EU's new biodiversity strategy for 2030.[113]

In addition to the challenges discussed in this section, there are also some positive messages. Throughout Europe, the importance of sustainable urban development and resilience to disasters has risen up the municipal agenda. Cities are front-runners in formulating, testing and exchanging innovative solutions for a more balanced growth and safe urban environment. The pace of land take for urban development has slowed down in the recent decade. That being said, the challenges will not disappear. Urban population continues growing. Climate change impacts are intensifying. Addressing the urban vulnerabilities, such as ageing or outdated infrastructure, requires substantial investment and is a long-term endeavour. However, resources are scarce and powers to take action vary across European cities. Against this background, both the importance and the challenge of keeping urban communities and assets safe are evident.

3.2.3. Environmental degradation

Environmental degradation[114], in particular damage to ecosystems and biodiversity loss, is heightening the risk of disaster. Ecosystems provide multiple services and benefits, including those highly relevant to disaster risk reduction and mitigation, such as regulation of climate, pests and diseases, water retention and flood control, landslide prevention and coastal protection. The ability of ecosystems to provide ecosystem services depends on their condition. Regrettably, biodiversity and ecosystems face immense pressure at a global and European scale.

The 2019 global assessment report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IBPES) warned that nature was declining globally and that the rate of species extinctions was accelerating at unprecedented rates. Three quarters of the land-based environment and about 66% of the marine environment have already been significantly altered by human actions. The key factors that have contributed to these negative trends are changes in land and sea use,

[109] Krausmann E., Girgin S., Necci A. (2019) Natural hazard impacts on industry and critical infrastructure: Natech risk drivers and risk management performance indicators, Journal of Disaster Risk Reduction, 40, 101163.

[110] Green infrastructure is defined as a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in both on-land (including coastal) and marine areas. Source: COM(2013) 249 final.

[111] Maes J, Zulian G, Günther S, Thijssen M, Raynal J, Enhancing Resilience Of Urban Ecosystems through Green Infrastructure. Final Report, EUR 29630 EN; Publications Office of the European Union, Luxembourg, 2019, doi:10.2760/689989, JRC115375.

[112] Maes, J., Teller, A., Erhard, M., Condé, S., Vallecillo, S., Barredo, J., Paracchini, M.L., Abdul Malak, D., Trombetti, M., Vigiak, O., Zulian, G., Addamo, A., Grizzetti, B., Somma, F., Hagyo, A., Vogt, P., Polce, C., Jones, A., Marin, A.I., Ivits, E., Mauri, A., Rega, C., Czúcz, B., Ceccherini, G., Pisoni, E., Ceglar, A., De Palma, P., Cerrani, I., Meroni, M., Caudullo, G., Lugato, E., Vogt, J.V., Spinoni, J., Cammalleri, C., Bastrup-Birk, A., San Miguel, J., San Román, S., Petersen, J., Kristensen, P., Christiansen, T., Zal, N., de Roo, A., Cardoso, A.C., Pistocchi, A., Del Barrio Alvarellos, I., Tsiamis, K., Gervasini, E., Deriu, I., La Notte, A., Abad Viñas, R., Vizzarri, M., Camia, A., Robert, N., Kakoulaki, G., Garcia Bendito, E., Panagos, P., Ballabio, C., Scarpa, S., Montanarella, L., Orgiazzi, A., Fernandez Ugalde, O., Santos-Martín, F., Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment. – 15 October 2020 – Available at https://publications.jrc.ec.europa.eu/repository/handle/JRC120383

[113] COM(2020) 380 final.

[114] Environmental degradation is a process through which the natural environment is compromised in some way, reducing biological diversity and the general health of the environment. This process can be natural in origin, or it can be accelerated or caused by human activities. Source: the European Environment Information and Observation Network (Eionet) https://www.eionet.europa.eu/gemet/en/concept/15154

direct exploitation of organisms, climate change, pollution, and invasion of alien species.[115]

The 2020 State of the European Environment report published by the European Environment Agency (EEA) concluded that Europe continued to consume more resources and contribute more to environmental degradation than other world regions. Over the past 10-15 years, the state of ecosystems and their services in Europe has continued to deteriorate.[116] Recent JRC research reveals that ecosystems have been altered even in protected areas.[117] [118] These changes have many negative impacts, including in terms of disaster risk. For example, the potential of ecosystems to deliver protection against riverine floods has decreased between 2006 and 2012, mainly due to the increase in imperviousness and land cover changes. Although the decrease in flood control potential is not very large at EU level, it is taking place in areas where there is a high need for ecosystems controlling floods. Overall, the demand for flood control in the EU has increased by 3% per decade, confirming that floodplains are increasingly built up.[119]

Degraded or disturbed ecosystems do not only have a reduced capacity to provide essential services and protect against adverse events, they are also less resilient to disasters. For instance, forests stressed by high temperatures and drought are more vulnerable to insect attacks, which can kill large numbers of trees.[120] In a vicious circle, disasters further contribute to damage in the natural environment, disturbing the ecological balance.

[115] IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio E.S., H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. Available at https://doi.org/10.5281/zenodo.3553579

[116] The European Environment Agency. The European environment – state and outlook 2020 (SOER2020). - Luxembourg: Publications Office of the European Union, 2019 – ISBN: 978-92-9480-090-9 – Available at https://www.eea.europa.eu/publications/soer-2020

[117] De la Fuente, B., Weynants M., Bertzky B., et al. (2020). Land productivity dynamics in and around protected areas globally from 1999 to 2013. PLoS ONE 15(8): e0224958. – Available at https://doi.org/10.1371/journal.pone.0224958

[118] Bastin L, Gorelick N, Saura S, et al. (2019). Inland surface waters in protected areas globally: Current coverage and 30-year trends. PLoS ONE 14(1): e0210496. – Available at https://doi.org/10.1371/journal.pone.0210496

[119] Maes, J., Teller, A., Erhard, M., Condé, S., Vallecillo, S., Barredo, J., Paracchini, M.L., Abdul Malak, D., Trombetti, M., Vigiak, O., Zulian, G., Addamo, A., Grizzetti, B., Somma, F., Hagyo, A., Vogt, P., Polce, C., Jones, A., Marin, A.I., Ivits, E., Mauri, A., Rega, C., Czúcz, B., Ceccherini, G., Pisoni, E., Ceglar, A., De Palma, P., Cerrani, I., Meroni, M., Caudullo, G., Lugato, E., Vogt, J.V., Spinoni, J., Cammalleri, C., Bastrup-Birk, A., San Miguel, J., San Román, S., Petersen, J., Kristensen, P., Christiansen, T., Zal, N., de Roo, A., Cardoso, A.C., Pistocchi, A., Del Barrio Alvarellos, I., Tsiamis, K., Gervasini, E., Deriu, I., La Notte, A., Abad Viñas, R., Vizzarri, M., Camia, A., Robert, N., Kakoulaki, G., Garcia Bendito, E., Panagos, P., Ballabio, C., Scarpa, S., Montanarella, L., Orgiazzi, A., Fernandez Ugalde, O., Santos-Martín, F., Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment. – 15 October 2020 – Available at https://publications.jrc.ec.europa.eu/repository/handle/JRC120383

[120] de Rigo, D., Libertà, G., Houston Durrant, T., Artés Vivancos, T., San-Miguel-Ayanz, J., Forest fire danger extremes in Europe under climate change: variability and uncertainty, EUR 28926 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN: 978-92-79-77046-3, doi:10.2760/13180, JRC108974.

Environmental degradation can also lead to new risks, such as new infectious diseases. Globally, the increase in human expansion into wildlife areas, sweeping changes in land use and ecological disruption they bring are important factors driving disease, in particular zoonoses – diseases that spread from animals to humans.[121] Even if a new infectious disease were to emerge in a remote area, in the current globalised world, it can quickly spread to new locations. The COVID-19 pandemic, caused by a coronavirus deemed to have spread from an animal to humans[122], is highlighting the threats originating from the increase in interactions between humans and the natural world.[123]

Policy responses have been insufficient to halt biodiversity loss and the degradation of ecosystem services. The EU is set to miss its 2020 targets set in the EU biodiversity strategy. The EEA warns that the overall outlook for Europe's environment in the coming decades is discouraging as ecosystem degradation and biodiversity loss, climate change, pollution and other global environmental challenges are interacting through numerous feedback loops at multiple levels.[124] It is against this background that making nature healthy again has been put at the heart of the European Green Deal and the new EU biodiversity strategy for 2030[125].

3.2.4. The changing security landscape

From a security point of view, Europe is facing an increasingly uncertain and unsettled world. To the east, countries are struggling with military, economic, political and energy-security related threats and vulnerabilities. In North Africa, the Sahel region and the Middle East, armed conflicts and political instability are escalating. The spread of ungoverned spaces has left a vacuum for terrorists and criminals to thrive. Intensifying regional rivalries, climate change and resource scarcity, coupled with demographic growth and state fragility, are feeding conflict and instability around the world.[126] They have led to a dramatic rise in civilian victims and refugees. By the end of 2019, over 79 million people were displaced worldwide.[127] Against this bleak backdrop, Europe has witnessed the biggest influx of migrants and refugees since the Second World War, with over 2 million people arriving on its shores since 2014.[128]

While turmoil in different regions of the world persists, multilateralism and the rules-based global order are under severe strain.[129] Competition between the great powers is now a major trend in world politics.[130] New powers are seeking to assert their place on the global stage, and established powers are behaving less predictably. Tendencies to pursue national interests are intensifying, alliances are shifting, making it harder to take concerted action and to resolve crises through diplomacy.

Instability abroad and developments on the international scene have an impact on the security environment in Europe. Without seeking to make a comprehensive security policy analysis, this section takes a look at how external and internal driving forces interact with and shape the security threats for the EU, in particular terrorism, hybrid, cyber and CBRN threats.

[121] A Alonso Aguirre, Changing Patterns of Emerging Zoonotic Diseases in Wildlife, Domestic Animals, and Humans Linked to Biodiversity Loss and Globalization, *ILAR Journal*, Volume 58, Issue 3, 2017, Pages 315–318, https://doi.org/10.1093/ilar/ilx035

[122] Report by the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19), 16-24 February 2020. Available at https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf

[123] For example, Damian Carrington (The Guardian), Coronavirus: "Nature is sending us a message", says UN environment chief. The Guardian, 25 March 2020. Available at https://www.theguardian.com/world/2020/mar/25/coronavirus-nature-is-sending-us-a-message-says-un-environment-chief

[124] The European Environment Agency. The European environment – state and outlook 2020 (SOER2020). - Luxembourg: Publications Office of the European Union, 2019 – ISBN: 978-92-9480-090-9 – Available at https://www.eea.europa.eu/publications/soer-2020

[125] COM(2020) 380

[126] COM(2017) 315.

[127] UNHCR. Global Trends, Forced Displacement in 2019. Available at https://www.unhcr.org/5ee200e37.pdf

[128] UNHCR, Operational portal, Refugee situations: Mediterranean situation. Available at https://data2.unhcr.org/en/situations/mediterranean#_ga=2.35247465.917801613.1584978224-817118242.1583678580

[129] The European Commission's contribution to the informal EU27 leaders' meeting in Sibiu (Romania) on 9 May 2019. Available at https://ec.europa.eu/commission/sites/beta-political/files/comm_sibiu_06-05_en.pdf

[130] European Union Institute for Security Studies (EUISS). Yearbook of European Security, 2019. Luxembourg: Publications Office of the European Union, 2019. Available at https://www.iss.europa.eu/sites/default/files/EUISSFiles/yes2019.pdf

3.2.4.1. The threat of terrorism in Europe: instability abroad and domestic extremism

Conflicts in different regions of the world are a major driver of terrorist activity.[131] Turmoil in the Middle East and North Africa over the last decade in particular have played an important role in shaping the terrorist threat globally and in Europe. Protracted crises in the region have facilitated the rise of ISIS/Daesh and the establishment of the Islamic State in 2014. The terrorist group attracted an unprecedented number of followers from around the world. Between 2011 and 2016, over 42 000 persons from over 120 countries travelled to Syria and Iraq to join ISIS/Daesh.[132] It is estimated that around 5 000 European nationals followed suit to become foreign terrorist fighters.[133] ISIS/Daesh became one of the four deadliest terrorist organisations in the world, killing over 27 000 people in the last five years[134], including numerous victims in the EU.[135]

The military defeat of the Islamic State in 2019 was a major achievement in the fight against terror. But it did not end the threat of jihadist terrorism. ISIS/Daesh remains active and there are signs of the group trying to rebuild.[136] The number of affiliates outside of Iraq and Syria continues to rise, as does the number of non-affiliate groups that have pledged allegiance to the group.[137] Moreover, Al-Qaeda has been reconsolidating its influence and actively encouraging terrorist attacks in the EU.[138] Multiple other individuals or groups are plotting alone or conspiring with others.[139] Terrorist organisations and threats persist beyond the Middle East, in particular in Afghanistan, parts of Africa and South-East Asia. As long as these regions suffer from instability, violence and weak governance, the threat of terrorism is unlikely to subside.

The setbacks experienced by ISIS/Daesh in Syria and Iraq had several implications for the jihadist terror threat in Europe. Firstly, they incentivised the European jihadist movement to shift the focus from travelling to fight in conflict areas to taking retaliatory action and to spreading the jihadist message in the EU.[140] Secondly, the loss of territory by the Islamic State triggered the return of European terrorist fighters from foreign battlefields to their home countries. It is estimated that approximately 30% have already come back[141] – alone or with families. Hundreds more remain in detention in Iraq and Syria and could return in future. Radicalised individuals with combat experience and international terrorist connections are perceived as a security threat as they may be ready to commit new atrocities or could serve as role models, propagandists, recruiters or fundraisers for terrorist organisations.[142]

People born and raised in the EU have not only joined ISIS/Daesh ranks abroad, they were also the main perpetrators of the recent jihadist attacks on European soil.[143] Some of these terrorists were guided by jihadist organisations, while others acted as 'lone wolves' inspired by

[131] Institute for Economics & Peace. Global Terrorism Index 2018: Measuring the impact of terrorism, Sydney, November 2018. Available at http://visionofhumanity.org/reports

[132] Radicalisation Awareness Network (RAN), RAN manual. Responses to returnees: Foreign terrorist fighters and their families, July 2017. Available at https://ec.europa.eu/home-affairs/sites/homeaffairs/files/ran_br_a4_m10_en.pdf#page=17

[133] EUROPOL, European Union Terrorism Situation and Trend Report 2018. Available at https://www.europol.europa.eu/activities-services/main-reports/european-union-terrorism-situation-and-trend-report-2018-tesat-2018

[134] Data from the Global Terrorism Index reports 2015-2019 by the Institute for Economics & Peace. Available at http://visionofhumanity.org/reports

[135] Because of unclear affiliation of some perpetrators, it is difficult to establish the exact number of victims of ISIS/Daesh attacks in the EU.

[136] United Nations, Letter dated 20 January 2020 from the Chair of the Security Council Committee pursuant to resolutions 1267 (1999), 1989 (2011) and 2253 (2015) concerning Islamic State in Iraq and the Levant (Da'esh), Al-Qaida and associated individuals, groups, undertakings and entities addressed to the President of the Security Council, S/2020/53. Available at https://undocs.org/S/2020/53

[137] Institute for Economics & Peace, Global Terrorism Index 2019: Measuring the Impact of Terrorism, Sydney, November 2019. Available at http://visionofhumanity.org/reports

[138] EUROPOL, European Union Terrorism Situation and Trend Report 2018. Available at https://www.europol.europa.eu/activities-services/main-reports/european-union-terrorism-situation-and-trend-report-2018-tesat-2018

[139] EUROPOL, European Union Terrorism Situation and Trend Report 2019. Available at https://www.europol.europa.eu/activities-services/main-reports/terrorism-situation-and-trend-report-2019-te-sat

[140] Idem

[141] EUROPOL, European Union Terrorism Situation and Trend Report 2018. Available at https://www.europol.europa.eu/activities-services/main-reports/european-union-terrorism-situation-and-trend-report-2018-tesat-2018

[142] Idem.

[143] EUROPOL, Terrorist threat in the EU remains high despite the decline of is in Iraq and Syria. Press release, 20 June 2018. Available at https://www.europol.europa.eu/newsroom/news/terrorist-threat-in-eu-remains-high-despite-decline-of-in-iraq-and-syria

propaganda.[144] This brings to the forefront the 'domestic' dimension of the threat and poses difficult questions about home-grown terrorism and radicalisation. Though the jihadist ideology, networks and recruitment strategies play an important role, they rely on finding a susceptible audience. In Europe, the audience has been young, second or third-generation immigrants from socioeconomically disadvantaged Muslim communities, with a criminal history or who have socialised in a criminal environment.[145] Research into the root causes of jihadist radicalisation in Europe identifies factors such as poor integration into society, perceived and real socioeconomic grievances, perceptions of injustice, a sense of alienation and resentment, personal problems and a search for a cause or sense of belonging.[146] It also highlights the importance of the crime-terrorism nexus and the role prisons play in radicalising individuals.

However, the problem of radicalisation and violent extremism is not limited to jihadist terrorism and can occur at any end of the political spectrum. In fact, Europe has had a decades-long history of ethno-nationalist/separatist, left-wing and anarchist terrorism. One of the worrying trends that has emerged over recent years is the rise in extreme right-wing sentiment and the number of arrests related to right-wing terrorism. Far-right extremist parties and movements have mobilised support by exploiting recent jihadist terrorist attacks, anxieties related to migration, fears of perceived attempts to Islamicise society and grievances linked to the alleged loss of national identity. Though the vast majority of these groups have not resorted to violence, they nevertheless help entrench a climate of animosity against minority groups. Such animosity, built on xenophobia, anti-Semitic, Islamophobic and anti-immigration sentiment, may lower the threshold for some radicalised individuals to use violence against people or the property of minority groups.[147]

Terrorism is a serious threat to Europe, not only because it poses a direct danger to the public, infrastructure and sites and artefacts of cultural heritage in the form of attacks. It has wider repercussions: it creates a feeling of insecurity, fuels distrust among different groups in society and towards the government, feeds prejudices and extremist views, and erodes the sense of a community. This poisonous atmosphere can lead to a vicious cycle of radicalisation, where right-wing extremists and radical Islamists feed off each other, becoming even more radicalised in the process.[148] As different groups spin divisive narratives of 'us versus them' in the context of multiple

[144] EUROPOL, European Union Terrorism Situation and Trend Report 2018. Available at https://www.europol.europa.eu/activities-services/main-reports/european-union-terrorism-situation-and-trend-report-2018-tesat-2018

[145] The European Policy Centre (EPC), the European Foundation for Democracy and the Counter Extremism Project (CEP). The Challenge of Jihadist Radicalisation - In Europe and Beyond, 2017. Available at https://www.epc.eu/en/Publications/The-Challenge-of-Jihadist-Radicalisation--In-Europe-and-Beyond~20ebbc

[146] Idem.

[147] EUROPOL, European Union Terrorism Situation and Trend Report 2019. Available at https://www.europol.europa.eu/activities-services/main-reports/terrorism-situation-and-trend-report-2019-te-sat

[148] The European Policy Centre (EPC), the European Foundation for Democracy and the Counter Extremism Project (CEP). The Challenge of Jihadist Radicalisation, In Europe and Beyond, 2017. Available at https://www.epc.eu/en/Publications/The-Challenge-of-Jihadist-Radicalisation--In-Europe-and-Beyond~20ebbc

sources of pressure, social cohesion erodes and societies become more polarised. Domestic and foreign groups can then exploit these divisions in order to pursue their agendas and sow instability.[149]

3.2.4.2. The increasingly hybrid nature of threats

The security environment in Europe is also shaped by geopolitical rivalry, and by the ever-increasing opportunities provided by digital technologies. The EU and its Member States face hybrid threats that permeate different aspects of life and increasingly blur the distinction between internal and external security, peace and war, civilian and military, physical and virtual, partners and adversaries/competitors.[150] [151] [152]

The term 'hybrid threats' indicates a mix of coercive and subversive activity, conventional and unconventional methods (i.e. diplomatic, military, economic and technological) used in a coordinated manner by state and non-state groups to pursue their strategic objectives. They employ a versatile arsenal of hybrid influencing techniques, which can include attacks on critical infrastructure, disinformation[153] campaigns, interference in elections, financing of anti-establishment parties, espionage, leaks of stolen data, economic pressure, investment in strategic industries and military incursions. Hybrid operations are deliberately designed to be difficult to detect or attribute and to remain below the threshold of formally declared warfare. It is often challenging to differentiate between individual incidents and coordinated campaigns. Hybrid campaigns target and exploit vulnerabilities. The ultimate goal is to weaken and destabilise the adversary by inflicting economic damage, meddling in decision-making processes, creating confusion, amplifying divisions and undermining public trust in government institutions, mainstream media and democratic processes.[154] [155] Hybrid threats are not a new phenomenon; many of the influencing techniques have existed for a very long time. However, the threats are evolving in step with changing geopolitical, technological and social trends.

3.2.4.3. Cyberspace and social media as the new battleground

Cyberspace and social media have become the new battleground for state and non-state groups. In cyberspace, hostile and illicit operations can be carried out at a distance and with a high level of anonymity. They require limited investment, but the impact can be immense. The digital transformation of the EU's economy and society, increasing reliance on information systems, cloud computing, big data, the rise of the internet of things, automation of industrial processes, and the roll out of 5G technology all open new possibilities that can be exploited by malevolent individuals and groups.[156]

The internet and social media are used as powerful tools for spreading disinformation, terrorist propaganda and extremist content. Terrorist groups and extremists use social networking sites, online video channels and radical chat rooms to engage with disaffected young people and to recruit new followers. States propagate disinformation with the help of online troll farms, bots, real and fake accounts. Growing polarisation in Europe provides an enabling environment for influencing campaigns that can

[149] Dixon T., Juan-Torres M. Is the Internet Eroding Europe's Middle Ground? Public Opinion, Polarisation and New Technologies, ESPAS Foresight Reflection Paper Series, March 2018. Available at https://espas.secure.europarl.europa.eu/orbis/sites/default/files/generated/document/en/Foresight%20Reflection%20Polarisation%20paper_V04.pdf

[150] JOIN/2018/16 final.

[151] Hybrid CoE (The European Centre of Excellence for Countering Hybrid Threats), Countering hybrid threats. Available at https://www.hybridcoe.fi/hybrid-threats/

[152] Treverton G.F., Thvedt A., Chen A.R., Lee K., McCue M. Addressing Hybrid Threats. © Swedish Defence University and the authors, 2018. ISBN 978-91-86137-73-1. Available at https://www.hybridcoe.fi/wp-content/uploads/2018/05/Treverton-AddressingHybridThreats.pdf

[153] Disinformation is understood as verifiably false or misleading information that is created, presented and disseminated for economic gain or to intentionally deceive the public, and may cause public harm. Source: COM(2018) 236.

[154] The European External Action Service, EU Defence and Security Spring Series: Tackling new threats, 30 April 2019. Available at https://eeas.europa.eu/headquarters/headquarters-homepage/61613/eudefence-and-security-spring-series-tackling-new-threats_hr

[155] JOIN(2016)018 final.

[156] Idem.

range from election debates[157] to migration[158] or even topics such as vaccination[159]. The most recent emergency, the COVID-19 pandemic, has demonstrated how adversaries use crisis situations and related public anxiety as an opportunity to spread online false or misleading information (e.g. about the new virus) to create confusion and undermine an effective public health response.[160]

Rapidly advancing machine learning techniques such as deep fakes are likely to bring disinformation campaigns to the next level by enabling malevolent individuals and groups to create alternative realities by using fabricated images, audios and videos that humans cannot distinguish from authentic ones. With the increasing availability of data and algorithms, the focus can also be expected to shift from manipulating content to back-end data manipulation.[161] Artificial intelligence is a game changer and a double-edged sword when it comes to cybersecurity: it can help detect malicious activities, and it can also help craft and disguise more sophisticated attacks.[162] [163]

3.2.4.4. CBRN threats – a growing concern

In addition to cyber-enabled threats, concerns have been growing in Europe about the potential use of chemical, biological, radiological or nuclear (CBRN) materials for malicious purposes. It is known that terrorist organisations are interested in and capable of using CBRN materials inside and outside the EU. In Syria, ISIS/Daesh used toxic chemicals as weapons on several occasions.[164] In the EU, law enforcement authorities recently disrupted several terrorist plots involving chemicals. Online, an increase in CBRN terrorist propaganda, tutorials and threats has been seen over recent years.[165] Concerns about hostile individuals and groups using CBRN substances were amplified in 2018 in the aftermath of the Novichok attack, which involved the use of a military-grade nerve agent against members of the public in Salisbury, UK.[166]

CBRN threats are by nature multifaceted and they are developing rapidly. Technologies are advancing and the barrier for gaining knowledge on the use of CBRN materials is becoming lower.[167] The internet facilitates access to know-how and substances. Some chemical materials have dual-use and are readily available. The advent of molecular biology techniques enables easier manipulation of bacteria and viruses. Cyber tools and new technologies such as drones can be used in attacks against nuclear facilities.

In conclusion, the security landscape is ever-evolving and increasingly complex. Threats originate from state and non-state, foreign and domestic individuals and groups. New technologies, cyber space and social media add a new dimension to this landscape, posing new challenges as well as opportunities. Internal and external security

[157] EU vs DiSiNFO. Trolling European Elections 2014 – 2019, News and analysis, 20 May 2019. Available at https://euvsdisinfo.eu/trolling-european-elections-2014-2019/?highlight=elections

[158] EU vs DiSiNFO, Conspiracies: it is impossible to see ostriches hiding their heads in the sand, News and analysis, 1 July 2019. Available at https://euvsdisinfo.eu/it-is-impossible-to-see-ostriches-hiding-their-heads-in-the-sand/?highlight=migration

[159] EU vs DiSiNFO, Figure of the Week: 93, News and analysis, 28 August 2018. Available at https://euvsdisinfo.eu/figure-of-the-week-93/?highlight=vaccine

[160] JOIN(2020)8 final.

[161] Meessen R., Torossian B., Bekkers F. A horizon scan of trends and developments in hybrid conflicts set to shape 2020 and beyond, February 2020. Available at https://hcss.nl/sites/default/files/files/reports/Horizon%20scan%20Hybrid%20Trends%20and%20Developments%20%282002%29.pdf

[162] Bordin, G., Hristova, M., Luque-Perez, E. (eds.), Security and Defence Research in the European Union: A landscape review, Executive summary, EUR 29864 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-11591-5, doi:10.2760/388606, JRC117742.

[163] EUROPOL, Internet Organised Crime Threat Assessment (IOCTA) 2018. Available at https://www.europol.europa.eu/activities-services/main-reports/internet-organised-crime-threat-assessment-iocta-2018

[164] United Nations, Letter dated 26 October 2017 from the Secretary-General addressed to the President of the Security Council conveying the seventh report of the Organisation for the Prohibition of Chemical Weapons., United Nations Joint Investigative Mechanism, S/2017/904. Available at https://www.securitycouncilreport.org/atf/cf/%7B65BFCF9B-6D27-4E9C-8CD3-CF6E4FF96FF9%7D/s_2017_904.pdf;

United Nations. Letter dated 24 August 2016 from the Secretary-General addressed to the President of the Security Council conveying the third report of the Organization for the Prohibition of Chemical Weapons-United Nations Joint Investigative Mechanism, 24 August 2016, S/2016/738/Rev.1. Available at https://undocs.org/S/2016/738/Rev.1

[165] EUROPOL, European Union Terrorism Situation and Trend Report 2019. Available at https://www.europol.europa.eu/activities-services/main-reports/terrorism-situation-and-trend-report-2019-te-sat

[166] The European External Action Service, Salisbury attack: EU condemns grave challenge to shared security; 17 countries expel Russian diplomats, 26 March 2018. Available at https://eeas.europa.eu/headquarters/headquarters-homepage_is/42128/Salisbury%20attack:%20EU%20condemns%20grave%20challenge%20to%20shared%20security;%2017%20countries%20expel%20Russian%20diplomats

[167] EUROPOL, European Union Terrorism Situation and Trend Report 2019. Available at https://www.europol.europa.eu/activities-services/main-reports/terrorism-situation-and-trend-report-2019-te-sat

are more intertwined than ever.[168] Countering malicious threats requires good understanding of the international situation and domestic tensions, grievances and vulnerabilities. The complexity of these challenges calls for a comprehensive response, based on cooperation across sectoral and territorial boundaries and a whole-of-society approach. Achieving a respite from malicious threats may not be within reach any time soon, but their impact will depend on the resilience of European societies. Resilience against radicalisation, violent extremism and disinformation, the resilience of critical infrastructure and supply chains, cybersecurity, and preparedness for nuclear and chemical accidents, irrespective of their cause, are important aspects to this response, as is action to promote conflict resolution and stability abroad.

3.2.5. Technological developments

The risk panorama across the EU is increasingly diversifying from more 'traditional' risks linked to natural hazards to technology-driven risks, in particular cyber-related risks. New technologies have the potential to both intensify threats and offer new solutions to address them.

The fast-paced development of digital technologies is transforming European society, the economy and public administration. Digital technologies are changing our daily life, our way of working and doing business, travel and communication. Though these changes bring immense benefits, they do not come without risks that can threaten people's well-being, businesses, critical infrastructure and wider security interests.[169] The more digitalised and interconnected we are, the more exposed we may become to malicious cyber activity. Cybersecurity threats are continuously on the rise and becoming more diverse and sophisticated. Both non-state and state groups use cyber space and tools to pursue their interests, ranging from financial gain to hacktivism or hybrid influencing. These groups might exploit unpatched vulnerabilities in existing technologies or make use of opportunities offered by emerging technologies.[170] The deployment of new technologies, such as 'fifth generation' mobile telecommunications (5G), cloud computing, the internet of things, the next

[168] The European External Action Service, EU Defence and Security Spring Series: Tackling new threats. – 30 April 2019. Available at https://eeas.europa.eu/headquarters/headquarters-homepage/61613/eudefence-and-security-spring-series-tackling-new-threats_hr

[169] The European Commission. Shaping Europe's Digital Future, Luxembourg: Publications Office of the European Union, 2020. ISBN 978-92-76-16363-3 doi:10.2759/091014 KK-03-20-102-EN-N. Available at https://ec.europa.eu/info/sites/info/files/communication-shaping-europes-digital-future-feb2020_en_4.pdf

[170] EUROPOL, Cybercrime is becoming bolder with data at the centre of the crime scene. Press release, 9 October 2019. Available at https://www.europol.europa.eu/newsroom/news/cybercrime-becoming-bolder-data-centre-of-crime-scene

generation internet and artificial intelligence, brings new challenges from a security perspective.

Artificial intelligence and quantum computing, like every technology or tool, can be used for malicious purposes. Artificial intelligence facilitates automated decision-making that could open up new avenues for manipulation and attack. Cybersecurity experts also caution that sometime in the future, quantum computers might be able to break the encryption methods that currently help protect everything from e-commerce transactions to health records, rendering today's cybersecurity virtually powerless.[171]

The internet of things is blurring the boundaries between physical and virtual worlds, with more objects and people interconnected through communication networks. Thousands of connected devices already surround us: virtual assistants, wearable health and fitness monitoring devices, smart TVs or refrigerators. These devices not only bring benefits to daily life, but also increasingly to industry, healthcare and public services in cities ('smart cities'). In the coming years, the internet of things and 'smart living' is set to expand with the rollout of 5G connectivity.

The rollout of 5G will enable more devices to be connected to the internet, at the same time increasing the volume of data generated. 5G will become the backbone of many IT applications, including in critical sectors such as energy, transport, banking, and health, as well as industrial control systems that contain sensitive information and support safety systems. As many critical services will depend on 5G, ensuring the security of these networks is a strategic goal.[172]

Growing connectivity across societies, economies, industries and countries, physical and virtual systems creates more incentives and access points for malicious individuals or groups, while simultaneously increasing the potential for damage. The threats stem not only from adversarial acts, but also from technical accidents. In increasingly interconnected systems, any disruption – whether triggered intentionally or unintentionally – is likely to have cascading effects.

Digital technologies are not the only changes affecting the threat landscape. Other developments in science, non-digital technological innovations, together with falling costs and easier access to knowledge are also affecting the nature of threats. For example, 3D printing can and has been used to fabricate homemade weapons in recent terrorist attacks in Europe[173], drones can be used to kill people remotely or attack critical infrastructure[174], and biotechnology would be a dangerous instrument in the hands of terrorists.

It is not only new technologies that are giving rise to new threats. Ageing IT and other infrastructure, legacy systems and technologies pose specific problems too. They are more prone to failure and can be easier targets for cyberattacks. Ageing infrastructure has already been identified as a concern in Europe in terms of preventing industrial accidents.[175] Operators of nuclear installations also recognise the importance of this issue and, under the supervision of national nuclear regulatory authorities, take comprehensive measures to systematically manage plant ageing and ensure the continued safety of the installations.[176]

Addressing this complex threat picture is a significant challenge for all disaster risk management bodies. Technology is changing at a fast pace and it is not an easy task to keep abreast of all societal implications and regulations. There are multiple vulnerabilities and potential targets. The threats are asymmetrical: perpetrators need to make a relatively small investment to exploit vulnerabilities and cause large-scale damage, while anticipating threats and designing comprehensive defence strategies

[171] Giles M. Five emerging cyber-threats to worry about in 2019, 4 January 2019. Available at https://www.technologyreview.com/2019/01/04/66232/five-emerging-cyber-threats-2019/

[172] COM(2019) 552 final.

[173] Dearden L. (The Independent). Use of 3D printed guns in German synagogue shooting must act as warning to security services, experts say. The Independent, 11 October 2019. Available at https://www.independent.co.uk/news/world/europe/3d-gun-print-germany-synagogue-shooting-stephan-balliet-neo-nazi-a9152746.html

[174] Reuters, Greenpeace crashes Superman-shaped drone into French nuclear plant, 3 July 2018. Available at https://www.reuters.com/article/us-france-nuclear-greenpeace/greenpeace-crashes-superman-shaped-drone-into-french-nuclear-plant-idUSKBN1JT1JM

[175] The European Commission, Lessons Learned Bulletin No. 7. Chemical Accident Prevention and Preparedness, Major accidents related to ageing. Available at https://minerva.jrc.ec.europa.eu/en/shorturl/minerva/7_mahb_bulletin_no7_fortheweb_a4

[176] The European Commission, First topical peer review on managing the ageing of nuclear installations highlights continued improvement of nuclear safety in Europe, 29 October 2018. Available at https://ec.europa.eu/info/news/first-topical-peer-review-managing-ageing-nuclear-installations-highlights-continued-improvement-nuclear-safety-europe-2018-oct-29_en

is a daunting and resource-intensive job. Europe is a net importer of cybersecurity products and solutions and largely depends on non-European providers. The risks defy geographic and sector borders. They even extend to space as satellites can also be the targets of cyberattacks. The potential impacts can range from billions of euros of economic losses to the shutdown of critical services, destabilisation of the government or the loss of life.

Against this background, the ongoing work to strengthen a culture of cybersecurity and build capabilities remains an important priority. The complexity of threats also calls for closer cooperation and synergies across sectoral, institutional and national borders. In terms of protecting critical digital and non-digital infrastructure from emerging threats, unconventional attacks and other risks, the thinking has shifted towards building resilience. This involves focusing on ensuring that infrastructure is equipped to recover from a disruption as quickly as possible rather than aiming to reduce all possible risks, as this might not be feasible or cost-effective.[177]

In addition to bringing threats and challenges, new technologies offer new solutions and tools to improve disaster risk management. Technologies help spread critical information more quickly, improve understanding of the causes of disasters, enhance early warning systems, facilitate the assessment of damage in new ways and add to the knowledge base of social behaviour in emergencies and the economic impact of a crisis.[178] Space technologies in particular, such as satellite imagery, satellite communications and global navigation systems, play an important role in supporting disaster risk management (see *Box 8*).

Box 8. The EU Copernicus programme and disaster risk management

The objective of the EU Copernicus programme is to monitor and forecast the state of the environment on land, sea and in the atmosphere, based on satellite Earth Observation and *in situ* (non-space) sensors. Copernicus offers free, reliable and up-to-date information that can be used in a wide variety of areas, including civil protection and disaster risk management.

Disaster risk management bodies in particular benefit from the Copernicus Emergency Management Service, which provides two types of services: mapping and early warning. Rapid mapping service can provide geospatial information within hours from a request in order to support response to emergency situations, in the immediate aftermath of a disaster. Risk and recovery mapping offers geospatial information that can feed into multiple disaster risk prevention, preparedness, reduction and recovery activities.

Early warning and monitoring component of the Copernicus Emergency Management Service is based on continuous observation and forecasts at European and global levels of floods, droughts and wildfires. The European Flood Awareness System (EFAS) provides overviews on ongoing and forecasted floods in Europe up to 10 days in advance. The European Forest Fire Information System (EFFIS) provides near real-time and historical information on forest fires and forest fire regimes in the European, Middle Eastern and North African regions. The European Drought Observatory (EDO) provides drought-relevant information and early-warnings for Europe. Global Flood Awareness System (GloFAS), Global Wildfire Information System (GWIS) and Global Drought Observatory (GDO) have a global scale and complement the aforementioned European systems.

In addition to the Emergency Management Service, other services of the Copernicus programme can support risk prevention and management with relevant data on climate, land cover and its changes, land use, water cycle, safety of infrastructure, urban hot spots, marine safety, etc.

The Copernicus programme is coordinated and managed by the European Commission. It is implemented in partnership with the Member States, the European Space Agency (ESA), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the European Centre for Medium-Range Weather Forecasts (ECMWF), EU Agencies and Mercator Océan.

For more information visit the Copernicus website at https://www.copernicus.eu/

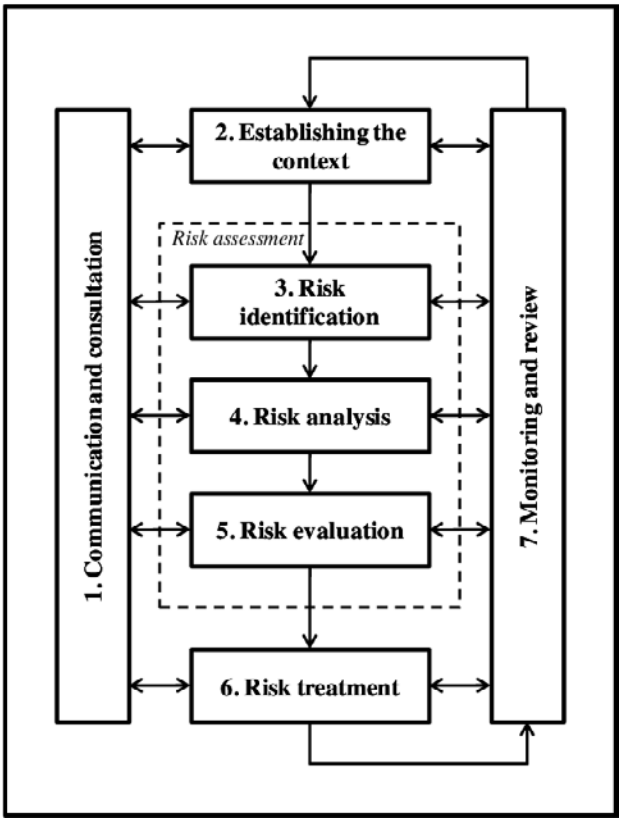
[177] The European Commission, Critical infrastructure protection. Available at https://ec.europa.eu/jrc/en/research-topic/critical-infrastructure-protection

[178] ITU, Minges M. Disruptive technologies and their use in disaster risk reduction and management, 2019. Available at https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Documents/2019/GET_2019/Disruptive-Technologies.pdf

4. UNDERSTANDING DISASTER RISKS IN THE EU: PROGRESS, CHALLENGES AND PROSPECTS

4.1. National risk assessments

As disaster risk is dynamic and evolving, it requires systematic monitoring in order to be able to adapt risk management policies to the changing situation. Regular assessments of disaster risks, capabilities to manage them and sharing risk information at EU level are important aspects of the disaster risk management work carried out under the UCPM. Although some Member States have a longer history of assessing disaster risks, most began this process only a decade ago, after the Council invited Member States to develop national approaches to risk analyses and make available to the Commission information on risks of relevance at EU level.[179] By now, national risk assessments are established practice in all EU Member States, in most cases embedded in national legislative or policy frameworks.



Source: ISO 31000

National risk assessments are primarily an instrument to support national disaster risk management work, however they are also a valuable source of information for action at EU level. For example, national risk assessments guide the process of prioritising cohesion policy investment. The precondition of having a risk assessment to guide investment in risk prevention and management was first brought in under the European Structural and Investment Funds in 2014-2020. National risk assessments are also an important source of information for prevention and preparedness work carried out in the framework of UCPM, for example feeding into the discussion on the response capacities needed in the European Civil Protection Pool[180] or the new rescEU reserve. Lastly, national risk assessments indicate the areas that could benefit from greater cooperation, exchanges of experience or capacity building in order to build up the evidence basis for disaster risk management policies across the EU.

The 2018 cycle of reporting on national risk assessments is the third time countries have carried out this process in the framework of the EU civil protection policy. With each new cycle, many countries have used the opportunity to upgrade their assessments by including new risks or scenarios, refining methodologies or broadening the expertise involved in the process. Having said that, the maturity of this work varies across Europe, as does the scope and approach to risk assessment.

National risk assessments differ in terms of the type of risks covered *(Figure 21)* and the adoption of an all-hazards approach, which makes it difficult to make a comprehensive assessment at EU level. Some assessments focus on natural hazards, others include technological accidents, and others still cover a whole spectrum of

[179] Council Conclusions on a Community framework on disaster prevention within the EU. 2979th Justice and Home Affairs Council meeting, Brussels, 30 November 2009. Available at https://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/jha/111537.pdf

[180] For example, see Centre for Strategy and Evaluation Services. Evaluation Study of Definitions, Gaps and Costs of Response Capacities for the Union Civil Protection Mechanism, 30 October 2019. Available at https://ec.europa.eu/echo/sites/echo-site/files/capacities_study_final_report_public.pdf

threats: those stemming from malicious intent, economic and financial risks, social unrest or even military threat. To some extent, these differences in scope can be explained by the differences in the institutional set-up and distribution of responsibility for the disaster risk assessment process among different bodies at national level.

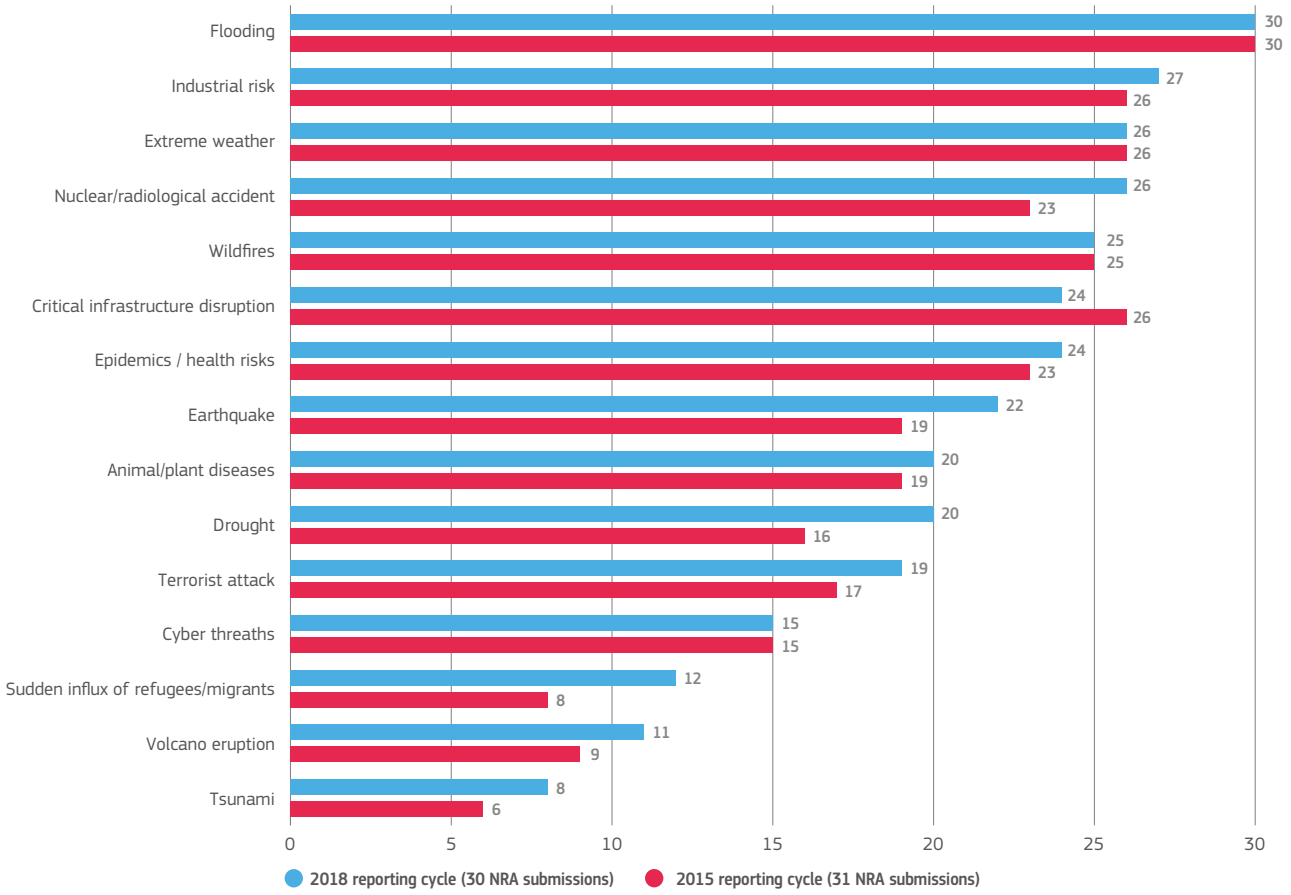


Figure 21. The most common risks in National Risk Assessments (NRAs) in 2015 and 2018 reporting cycles[181]

Though the UCPM legislation is not prescriptive in terms of which hazards and threats must be addressed in a national risk assessment, it does recommend taking an all-hazards approach, given that the overall objective of the UCPM is to protect people, the environment and property from "*all kinds of natural and man-made disasters, including the consequences of acts of terrorism, technological, radiological or environmental disasters, marine pollution, and acute health emergencies*".[182] Other international frameworks, such as the Sendai Framework for Disaster Risk Reduction 2015-2030, the OECD/G20 framework on disaster risk assessment and risk finance[183] or the Paris Agreement, also recommend taking a holistic and cross-sectoral approach to risk assessment and management in order to tackle the full range of risks threatening societies as well as systemic interdependencies between them.

[181] In the 2018 reporting cycle, 26 EU Member States and 4 participating states to the Union Civil Protection Mechanism submitted summaries or full national risk assessments.

[182] Article 1 of Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism, amended by Decision No 2019/420.

[183] G20/OECD methodological framework on disaster risk assessment and risk financing, 2012. Available at http://www.oecd.org/gov/risk/g20oecdframeworkfordisasterriskmanagement.htm

Box 9. Evolving thinking on disaster risks: GAR 2019

The UN Global Assessment Report on Disaster Risk Reduction (GAR) is the flagship biannual report presenting an overview of global action to reduce disaster risk. The GAR is a collaborative product based on worldwide contributions from national and international, public and private bodies working in disaster risk science and research, including the European Commission's Joint Research Centre.

The 2019 edition of the GAR reflects on how disaster risk science is changing. It concludes that "*The era of hazard-by-hazard risk reduction is over. We need to reflect the systemic nature of risk in how we deal with it. <…> We must move away from working on distinct areas of risk (e.g. spatial, geographic, temporal, disciplinary) when designing and implementing interventions. While it can be practical to categorize risk so that we can delegate responsibility to different organizations, <…> we need to incentivize transdisciplinary integrated, multi-sectoral risk assessment and decision-making <…> if we are to improve our understanding of complex systems and risk and collectively identify solutions.*"[184]

The comparison of national risk assessments shared with the Commission in 2015 and 2018 reporting cycles shows a degree of continuity in the overall portfolio of disaster risks assessed in Europe, however, some risks are seeing increasing attention. These notably include geophysical risks (earthquakes, tsunamis and volcanic eruptions), drought, the risk of nuclear or radiological accidents, a sudden influx of refugees and migrants and other risks that now feature in national risk assessments more often. A qualitative review of reports reveals that, in addition to covering new risks, countries have also worked on deepening the understanding of risks by examining new scenarios. For example, the reports put increasing focus on flooding events other than fluvial floods (i.e. coastal and pluvial/flash floods) and cover a wider range of extreme weather scenarios. Wildfires remain one of the key disaster risks faced in Europe, with a number of reports assessing new scenarios, cascading effects, drawing on new data and learning from the dramatic wildfire seasons seen in the last years. A number of national reports, despite being drafted before the outbreak of the COVID-19 pandemic, signalled an increasing concern in some parts of Europe about the risk of epidemics and other health risks.

As some national risk assessments focus predominantly on the natural hazards that have caused the most damage in the past, others also look at the rapidly changing security environment and the implications it has for man-made threats. The level of threat linked to terrorist or cyberattacks is considered to have increased in the last few years. Moreover, hybrid threats emerge as one of the new themes in national risk assessments. The perceived deterioration and complexity of the security context is raising concerns about the increasing risks to the safety of critical infrastructure and the smooth delivery of vital services.

A number of national risk assessments reflect a growing recognition that risks are interdependent and characterised by a high degree of complexity. Several reports seek to capture this complexity by adopting a broad 'societal security' perspective on risks or by carrying out a multi-hazard/multi-risk analysis. The benefit of a multi-risk assessment is that it gives a better understanding of the scope of damage that disasters could potentially cause, and can feed into prevention and preparedness work on a wider range of disaster scenarios.[185] However, it remains challenging, in particular when it comes to assessing potential disruption to critical infrastructure with cascading effects.[186] Although the reports tackle cross-sectoral interdependencies between risks to some extent, the cross-border/regional/international dimension remains largely outside the scope of national assessments.

Another trend seen in the recent national risk assessments is a more developed forward-looking perspective. Several national reports now discuss factors and trends that may impact disaster risks, lead to new types of incident or affect risk management in the future. These include climate change *(Box 10),* demographic developments (e.g.

[184] United Nations Office for Disaster Risk Reduction, 2019 Global Assessment Report on Disaster Risk Reduction, distilled. Available at https://gar.undrr.org/sites/default/files/gar19distilled.pdf

[185] SEC(2010) 1626 final.

[186] Girgin, S., Necci, A., Krausmann, E. (2019), Dealing with cascading multi-hazard risks in national risk assessment: The case of Natech accidents, Journal of Disaster Risk Reduction, Vol. 35, 101072.

ageing societies), migration trends, technological advances, globalisation and developments in international relations. Taking a forward-looking perspective on disaster risks is particularly important when it comes to strategic planning and longer-term investments over and above the more immediate preparedness and response needs.

Box 10. Climate change as a driver of disaster risk in national risk assessments

The impact of climate change on disaster risks is a longstanding topic. Back in 2009, when the Council invited the Member States to develop national risk analyses, it recommended taking into account the future impact of climate change.[187] The UCPM Decision adopted a few years later highlighted that future disasters were expected to be more extreme and complex as a result of climate change. One of the recommendations reiterated after the review of national submissions sent for the 2015 reporting cycle was to better incorporate the impact of climate change in national risk assessments.[188]

The national risk assessment submissions that the Commission received in the 2018 reporting cycle show progress on this front. 25 of the 30 reports mention climate change as a driver of risk. Most often, climate change is mentioned in relation to weather-related disaster risks. Some Member States also analysed climate change impacts on biological or man-made risks: vector-borne diseases, invasive alien species, industrial accidents, critical infrastructure disruption, the security of food supply or large-scale influx of refugees/migrants.

Approximately half of the countries based their analyses on scenarios and projections taken from climate models, looking ahead to 2050 and/or 2100. Two Member States presented a comparison of the current and future likelihood and impact of different disaster risks with a changing climate. Most countries involved their national authority responsible for climate change in drafting the risk assessment and made reference to existing climate risk assessments and climate change adaptation strategies.

Given the factors that magnify disaster risk, such as climate change, systemic interdependencies and new and emerging risks, there has been a growing realisation in Europe of the need to better prepare for low likelihood events that are difficult to predict but can be potentially catastrophic. At EU level, there is a particular interest in improving capacity to anticipate and prepare for extreme events with transboundary repercussions. With this in mind, the 2019 revision of the UCPM legislation brought in new aspects to be covered in future national risk assessments. Specifically, Member States are now required to share information on their key disaster risks that have cross-border impacts, on low-probability risks with a high impact, and on priority prevention and preparedness measures to tackle these risks.[189]

Generally, situations where the consequence of an event is catastrophic but the likelihood is low tend to receive limited attention in risk assessments due to their rarity, a lack of historical experience or limited data. Moreover, the low likelihood of an extreme scenario is also likely to lead to it being 'deprioritised' in the decision-making process. Low-probability risks with a high impact present a particular problem for prevention and preparedness because the costs of both action and inaction can be high. There is the possibility that (expensive) ex ante measures aimed at mitigating the potential consequences of low-probability risks may never pay off if the risk does not materialise. While incentives to prepare for some unlikely events might not be sufficient at individual country level, the magnitude of potential impact might be the rationale for investing in collective safety nets that protect in such situations.

[187] Council Conclusions on a Community framework on disaster prevention within the EU, 2979th Justice and Home Affairs Council meeting, Brussels, 30 November 2009. Available at https://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/jha/111537.pdf

[188] SWD(2017) 176 final.

[189] Article 6 of Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism, amended by Decision No 2019/420.

Box 11. Low-probability risks with a high impact – the concept

There is no universally agreed definition of what a low-probability, high-impact risk is. In the EU, an 'operational' definition of such risks was adopted for the purpose of establishing the rescEU reserve capacities, since their aim is to help respond to extreme situations characterised by:

(a) the unpredictability or the extraordinary nature of a disaster;

(b) the scale of a disaster, including mass casualties, mass fatalities, and mass displacement;

(c) the protracted duration of a disaster;

(d) the degree of complexity of a disaster;

(e) the potential risk of severely disrupting the functioning of the national government, including the provision of social, environmental, economic and public health services or the disruption of critical infrastructure referred to in Article 2(a) of Council Directive 2008/114/EC;

(f) geographical range, including the potential for impacts to spread beyond borders;

(g) other factors such as full activation of the Council's Integrated Political Crisis Response arrangements or citing the solidarity clause under Article 222 of the Treaty on the Functioning of the European Union.[190]

Incidentally, the COVID-19 pandemic, which has affected every single EU Member State, is re-confirming the need for action to improve capacity to anticipate and prepare for large-scale, transboundary disasters in the EU. National risk assessments will continue to provide important input to this work, at both national and EU level. Therefore, it is essential that they continue to be developed further to provide decision-makers with the best available evidence. At the same time, further thinking is warranted on how to complement the inherently different national perspectives on disaster risk and draw up a more comprehensive picture of the EU-wide needs to build resilience.

4.2. The data challenge

Reliable data on exposure to risks and losses from past disaster events is essential in order to take informed decisions on how to better protect people, public assets and nature, prioritise investment in prevention and resilience, monitor the effectiveness of action and manage financial risks to economies. However, the availability and quality of such data remains a major challenge at all levels: local, national, EU and indeed global.

Statistics from even the most comprehensive currently available disaster loss databases are known to be an underestimation of the full scale of the effects of disasters. Data collected by reinsurers may not reflect well the public sector losses because these losses are often not insured. Estimates available are limited to direct damage, they do not capture indirect costs or spillover effects stemming from the disruption of economic flows or social networks. Disasters often harm the natural environment or cultural heritage, but again, these impacts are not reflected in the data on losses. Many facets of natural and cultural heritage are irreplaceable and often cannot even be monetised.

The availability of data varies from risk to risk. For example, there is now more data on floods as the Floods Directive requires the collection of information on flood events. However, even for relatively well-accounted disasters such as floods, the EU lacks a defined and agreed methodology on how to record the adverse economic consequences resulting from those events. Although some historical comparable data is available on weather-related and geophysical disasters, it remains challenging to measure the impact of other types of adverse events such as cyber-incidents[191], the disruption of critical infrastructure or epidemics. Data collection on industrial accidents faces particular challenges due to the decentralised nature of this process, private ownership, and different requirements applicable to different

[190] Commission Implementing Decision (EU) 2019/570 of 8 April 2019 laying down rules for the implementation of Decision No 1313/2013/EU of the European Parliament and of the Council as regards rescEU capacities and amending Commission Implementing Decision 2014/762/EU.

[191] SWD(2018)403 final.

types of establishments (i.e. upper/lower tier, covered/not covered by the Seveso Directive).

The quality and availability of data also varies across countries. Although some EU Member States have disaster loss databases that record direct economic losses, they also face challenges due to a lack of a standardised approach to data recording and collection and to the multiple data providers involved, including insurance companies and regional and local authorities.

A lot of work has been carried out over the past few years to improve disaster risk and loss data. At an international level, the Sendai Framework Monitor was created to track progress on the seven targets set under the Framework. It includes reporting on direct economic losses for the period 2015-2030 (under Target C 'Reduce direct disaster economic loss in relation to global gross domestic product by 2030'). This reporting is still at an early stage and the scope and quality of the data has yet to be improved to be able to derive reliable national, global or regional trends.

The EU is also working to create more open and accessible disaster loss data, for example, by developing tools such as the Risk Data Hub *(Box 12).* The Commission is currently assessing loss data recording, collection and sharing frameworks in the EU and the horizontal and technical requirements needed to achieve systematic data collection, access and reuse, while ensuring data quality and protection in line with EU data protection legislation.[192] More and better data on climate-related risk and loss will be a separate work strand of the EU's new adaptation strategy due in 2021. The Commission has also been working on developing natural capital accounting as a structured way of measuring ecosystems and their services, which can help quantify the losses to ecosystems and the value of mitigation services.[193]

Box 12. The DRMKC Risk Data Hub[194]

In 2017, the Commission's Disaster Risk Management Knowledge Centre (DRMKC) started developing the Risk Data Hub with three objectives in mind:

(i) to learn from past disasters to be better prepared for the future;

(ii) to facilitate the use of available research results for disaster risk management policies and

(iii) to strengthen the link between local and the international dimensions.

The DRMKC Risk Data Hub takes the form of a GIS-based platform with publicly accessible disaster risk data. The underlying database has been designed to host data on loss from natural and technological hazards and malicious threats. It is compliant with frameworks such as the INSPIRE Directive[195] and the Sendai Framework, and has been inspired by a number of national databases.

The platform enables users to enter data at any geographical scale (local, sub-national, national level) that can then be aggregated to provide national and European figures, following harmonised methodologies. Currently, the DRMKC Risk Data Hub pools and curates data from several EU and external open source databases, such as EFFIS[196], MARS[197], EM-DAT[198] and others. The DRMKC Risk Data Hub also provides access to risk data produced by different scientific communities and research projects. One example of research results that will be available on the platform is the visualisation of potential loss due to climate change, as estimated by the PESETA project (see section 3.2.1.).

[192] If and when personal data is processed, this processing should fully comply with the EU data protection legislation. Principles enshrined in General Data Protection Regulation 2016/679 (GDPR), such as purpose specification and data minimisation (only personal data that is adequate, relevant and limited to what is necessary in relation to the purpose may be processed) should be respected. In particular, if the processing is based on an EU or national legislation establishing a legal obligation or the performance of a task carried out in the public interest, this legislation has to provide specific and suitable measures to safeguard the rights and freedoms of data subjects.

[193] For example, see the Knowledge Innovation Project INCA, available at https://ec.europa.eu/environment/nature/capital_accounting/index_en.htm.

[194] Available at https://drmkc.jrc.ec.europa.eu/risk-data-hub.

[195] The INSPIRE Directive aims to create a European Union spatial data infrastructure for the purposes of EU environmental policies and policies or activities that may have an impact on the environment. See https://inspire.ec.europa.eu/.

[196] EFFIS: The European Forest Fire Information System https://effis.jrc.ec.europa.eu/.

[197] MARS: Major Accident Reporting System for submitting accident reports to the European Commission according to the criteria of the Seveso II Directive 96/82/EC. http://eMARS.jrc.ec.europa.eu.

[198] EM-DAT: The Emergency Events Database, Université catholique de Louvain (UCL), CRED, D. Guha-Sapir - www.emdat.be.

Box 12. The DRMKC Risk Data Hub (continued)

The DRMKC Risk Data Hub is being designed as a platform for collaboration and development of collective knowledge in the EU. Only by bringing together the fragments of information currently spread across different sectors and owned by different bodies will it be possible to transform information into usable knowledge to build resilience to future shocks.

The EU is working on sharing data on losses with the insurance industry through pilot and case study projects, for example under the Copernicus Climate Change Service. Under the UCPM, the EU is supporting the creation of national loss databases and development of methodologies to collect data on losses. In the framework of the future Horizon Europe and Digital Europe programmes, the EU will invest in research and innovation projects that harness advanced digital solutions such as artificial intelligence, digital twins and big data analytics to facilitate the collection, processing and use of data on losses to help mitigate risk.

5. CONCLUSIONS AND FUTURE DIRECTIONS FOR DISASTER RISK MANAGEMENT IN THE EU

The disaster risk landscape in Europe is constantly evolving. There are multiple forces at play that are (re)shaping hazards and threats as well as the exposure and vulnerability of our societies to adverse events. In the future, we can expect more extreme events, sudden and slow-onset, and potentially causing increasing damage. It is crucial to put in place arrangements to both avoid and face these challenges, through better prevention, preparedness, and improving our capacity to respond to and withstand disasters.

5.1. Addressing the major causes of risk is essential for the long-term prevention of loss of life, damage to infrastructure, economy, environment and cultural heritage.

The EU is stepping up its action on fighting climate change and environmental degradation, which are driving disaster risk, in addition to causing many other detrimental effects. At the heart of this action is the European Green Deal adopted by the Commission in December 2019[199]. It contains a set of policy and legislative initiatives aimed at making Europe the first climate-neutral, climate-resilient and environmentally sustainable continent over the next decades. As part of the European Green Deal, the Commission has proposed the first ever EU Climate Law[200] that enshrines the EU's climate-neutrality objective – reducing greenhouse gas emissions to net zero by 2050 – in a legal instrument. The EU is also considering increasing the ambition enshrined in its nationally determined contribution under the Paris Agreement. In addition to wide-ranging mitigation action guided by ambitious targets, adaptation is another priority. As climate change is already having and will continue to have impacts, boosting the EU's adaptive capacity and resilience, reducing vulnerability and impacts and monitoring progress are all crucial. To this end, the proposal on the EU Climate Law includes the requirement for Member States to continue developing and implementing national adaptation strategies and plans. The Commission is also working on the new EU adaptation strategy to be adopted in 2021, which will aim at enhancing the EU's resilience to climate change and disaster risks and impacts.

Given the vital role nature plays in mitigating and adapting to climate change, new EU strategies on biodiversity[201] and forests will step up action to counter the loss of biodiversity, the degradation of ecosystems and will help prevent disasters such as wildfires. As climate change and environmental degradation are global phenomena and cannot be effectively addressed within national or regional borders only, the EU will step up its 'green deal diplomacy' to lead international action towards a more sustainable path. And to complement these policies, regulatory work and diplomacy, the European Climate Pact[202] should mobilise broader public engagement on climate and environmental action throughout the EU.

As food systems remain one of the key drivers of climate change and environmental degradation, the EU's farm-to-fork strategy adopted in 2020[203] sets out action to accelerate the transition to sustainable food systems. The strategy also highlights the importance of working on food security and on the resilience of the food system as it is coming increasingly under threat due to more frequent droughts, floods, wildfires and new pests.

[199] COM(2019) 640 final.
[200] COM(2020) 80 final.
[201] COM(2020) 380 final.
[202] European Climate Pact, available at https://ec.europa.eu/clima/policies/eu-climate-action/pact_en
[203] COM(2020) 381 final.

5.2. The transboundary nature of disaster risk, increasing complexity and the emergence of new threats require more cooperation across borders and sectors, in all phases of risk management.

Several EU legal acts already require a collaborative approach to disaster risk assessment and management across borders. The EU has long supported cross-border and transnational cooperation, for example with the UCPM, territorial cooperation programmes funded by cohesion policy (Interreg)[204] and macro-regional strategies. There are many inspiring examples of cross-border and transnational cooperation on risk management across Europe. Nevertheless, there is scope to increase the level of action. Experience shows that anticipating and preventing shared risks receive less attention from public authorities than cooperation in emergencies. And although international arrangements for mutual assistance in a crisis situation are common practice, legal and administrative obstacles persist, hindering effective response to disaster events in border regions.[205]

The 2019 UCPM revision sharpened the focus on cross-border cooperation and between Member States prone to the same types of disasters. As regards funding, the Commission is proposing that any investment programme co-funded by cohesion policy could finance cooperation between regions and across border, i.e. not just territorial cooperation programmes (Interreg).[206] The Commission is also proposing a new voluntary mechanism for resolving legal and administrative obstacles encountered in cross-border cooperation.[207] Member States are invited to make use of these opportunities to support their cooperation work.

Cooperation is increasingly important not only across national, but also across sectoral boundaries, as risks are ever more interconnected. The experience with the complex emergency caused by the COVID-19 pandemic has demonstrated the importance of cross-sectoral preparedness and response and has shown the scale of concerted action required.

In terms of coherence across different disaster risk-relevant policies, it is important to emphasise the links with climate change adaptation work. Closer cooperation with climate and environmental authorities is key to ensure that risk reduction measures respond to the evolving climatic situation. There are also beneficial link-ups to be made. For example, climate change vulnerability assessments should feed into the national risk assessments. Work on renovating buildings to improve energy performance should simultaneously strengthen their seismic resilience. Nature-based solutions could be used more widely for cost-effective disaster risk management, and early warning systems could be improved by integrating forecasts on climate change impacts.

5.3. Strategic investment in prevention, preparedness and resilience remains a priority.

A sustained flow of investment is needed to reduce the impacts of intensifying hazards, minimise response needs and make societies stronger to cope with the next disaster. In this respect, EU and other funds available to national authorities should be used to their full potential.[208] In the next EU multiannual budget for 2021-2027, cohesion policy and the common agricultural policy will remain the biggest sources of EU funding for risk management and climate change adaptation. They can be used for multiple types of risks and to support investment strategies tailored to specific national, regional, local or cross-border needs.

In addition to funding available under the cohesion policy and the common agricultural policy, the Commission has proposed increasing the resources for disaster risk management needs under other EU instruments. These include

[204] Interreg provides a framework for joint action between Member States and also between Member States and third countries to find common solutions to shared problems. It promotes exchanges of experience across borders and facilitates cooperation. Available at https://ec.europa.eu/regional_policy/en/policy/cooperation/european-territorial/.

[205] European Commission. Cross-border review. Available at https://ec.europa.eu/regional_policy/en/policy/cooperation/european-territorial/cross-border/review/.

[206] COM(2018) 375 final.

[207] COM(2018) 373 final.

[208] COM(2017) 773 final.

the UCPM (see also section 5.4. below), the new EU4Health Programme,[209] which will support EU and Member States' capacity to address cross-border threats to health and the Horizon Europe programme. Horizon Europe, in particular the cluster 'Civil Security for Society', will support research and innovation on EU resilience and preparedness to disasters, security challenges and emerging threats. It will build on lessons learnt from the COVID-19 pandemic in terms of preparedness and capacity building for crises, including health and cross-sectoral crises. The proposed budget for this cluster is EUR 2.8 billion for 2021-2027.[210] In addition, the Horizon Europe initiative entitled 'Mission on Climate Change Adaptation including Societal Transformation'[211] will test, evaluate and scale-up adaptation solutions with the aim of triggering societal transformation in systems central to resilience building and sustainable growth (e.g. health, primary production, forestry, water, environment and biodiversity, and infrastructure).

As the investment needs are immense, it will be important to ensure that they target priority areas, are cost-effective and future-proof. Going forward, the Commission has proposed strengthening the strategic approach to investment co-financed under cohesion policy by requiring investment programmes to be based on a national or regional disaster risk management plan, including a robust assessment of risks, longer-term climate change impacts, and the costs and benefits of different risk management measures.[212] In the context of EU funding, the Commission recommended that, whenever possible, preference should be given to 'no-regrets' options, such as nature-based solutions that have multiple benefits in addition to risk management. For the EU Solidarity Fund, further reflection is needed on how to better align the funding eligibility conditions and the 'build back better' principle to ensure that rebuilt infrastructure is more resilient to future disasters.[213]

Though it is crucial to invest in prevention, preparedness and resilience, making a business case for spending on disasters that might never materialise is often challenging. With this in mind, the Commission has joined forces with the World Bank to assess and determine ranges of cost-benefit ratios for different types of risk reduction measures (structural and non-structural) in Europe. This should help demonstrate the value of prevention and secure the necessary financing. In particular, the 'triple dividend of resilience' approach[214] is a useful lens for screening investment in disaster risk reduction and accounting for different types of benefits (dividends of resilience) that it can yield, namely: (i) avoiding losses when disasters strike; (ii) stimulating economic activity by reducing the risk of disaster; and (iii) co-benefits of a specific investment to society, environment, and cultural heritage. The second and third type of benefits are typically overlooked, though they materialise even in the absence of a disaster and support the economic argument of investing in disaster risk management. For malicious man-made threats and the protection of critical infrastructure, resilience building can yield an additional dividend, which is to reduce the effectiveness of perpetrators' actions and as a result, deter attacks.

The need for investment throughout the EU cannot be met by public funding alone. That is why the EU is engaging with the private sector to incentivise greater flows of private investment in climate change adaptation and resilience against disasters. This is one of the objectives of the new Sustainable Europe Investment Plan[215] and of

[209] COM(2020) 405 final.

[210] COM(2018) 435 final.

[211] The European Commission, Horizon Europe, the next research and innovation framework programme. Mission area: Adaptation to climate change including societal transformation. Available at https://ec.europa.eu/info/horizon-europe-next-research-and-innovation-framework-programme/mission-area-adaptation-climate-change-including-societal-transformation_en.

[212] Proposal for a Regulation of the European Parliament and of the Council laying down common provisions on the European Regional Development Fund, the European Social Fund Plus, the Cohesion Fund, and the European Maritime And Fisheries Fund and financial rules for those and for the Asylum and Migration Fund, the Internal Security Fund and the Border Management and Visa Instrument. COM(2018) 375 final.

[213] SWD(2019) 186 final.

[214] Tanner T.M., Surminski S., Wilkinson E., Reid, R., Rentschler J.E., and Rajput S. (2015) The Triple Dividend of Resilience: Realising development goals through the multiple benefits of disaster risk management. Global Facility for Disaster Reduction and Recovery (GFDRR) at the World Bank and Overseas Development Institute (ODI), London. Available at: https://www.gfdrr.org/sites/default/files/publication/The_Triple_Dividend_of_Resilience.pdf.

[215] The European Commission, the European Green Deal Investment Plan and Just Transition Mechanism. Available at https://ec.europa.eu/info/publications/200114-european-green-deal-investment-plan_en.

ongoing work on the sustainable finance agenda for private investment.[216]

5.4. The EU needs to further boost its collective capacity to respond to high-impact disasters with transboundary effects.

Recent years have shown how extreme, large-scale events can overwhelm not only national, but also collective EU crisis response mechanisms. These events have also caused the most damage and they are becoming more likely in the future due to multiple risk drivers. Even if the likelihood of a worst-case scenario remains low, this does not prevent catastrophic impacts from materialising if it were to occur. However, there is often limited appetite and incentives to invest in preparedness for rarely seen scenarios.

Important steps to address this concern at EU level were taken with the 2019 reform of the UCPM that strengthened the European Civil Protection Pool, created the rescEU safety net and boosted the anticipatory capacity through better sharing of information on risks that could potentially lead to overwhelming disasters (i.e. cross-border risks and low-probability risks with a high impact). Shortly after the reform, the newly upgraded EU crisis management system was tested by the unprecedented emergency caused by the COVID-19 pandemic.

On the one hand, this public health crisis has accelerated the implementation and showed the added value of having rescEU reserve capacities, such as a stockpile of medical equipment. On the other hand, it has once again exposed the limitations inherent in an approach largely based on mutual assistance between EU Member States, which might not be available in the event of a large-scale crisis. The interconnectedness of our societies tackling the same emergency and their resulting difficulty to help each other has demonstrated the need for more action at EU level, as requested by the European Council and the European Parliament *(Box 13)*.

Box 13. European institutions call for a strengthening of the EU's crisis management system

On 26 March 2020, **the European Council** issued a joint statement noting that *"We must <...> draw all the lessons of the present crisis and start reflecting on the resilience of our societies when confronted with such events. In that respect, the time has come to put into place a more ambitious and wide-ranging crisis management system within the EU. We invite the Commission to make proposals in that respect"*.[217]

On 17 April 2020, **the European Parliament** adopted a resolution in which it called on the Commission to strengthen all components of crisis management and disaster response, and expressed the view that European disaster risk management, preparedness and prevention should be enhanced.[218]

[216] The European Commission, Sustainable finance. Available at https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance_en.

[217] Joint statement of the members of the European Council, 26 March 2020. Available at https://www.consilium.europa.eu/en/press/press-releases/2020/03/26/joint-statement-of-the-members-of-the-european-council-26-march-2020/.

[218] European Parliament Resolution of 17 April 2020 on EU coordinated action to combat the COVID-19 pandemic and its consequences, 2020/2616(RSP). Available at https://www.europarl.europa.eu/doceo/document/TA-9-2020-0054_EN.html.

One lesson of the pandemic is that Europe must be able to react more quickly and flexibly in serious cross-border crises, given the scale of the potential disruption to our economies and societies. Drawing on the experience with the COVID-19 outbreak, the Commission has put forward a new proposal for a reinforced UCPM[219] which forms part of the overall recovery plan 'NextGenerationEU', in particular pillar three on 'Addressing the lessons of the crisis'.[220] The Commission has proposed strengthening the EU civil protection framework by

(i) stepping up cross-sectoral, collective work to build resilience to transboundary disasters;
(ii) making the EU response to large-scale emergencies more flexible and
(iii) increasing the budget.

Although the governance framework plays a role in the effectiveness of EU crisis response and thus should be further strengthened, it is not the only factor. The level of preparedness is another important variable: we can and we must be better prepared for when the next big disaster hits, be it a pandemic, a nuclear accident or any other adverse event.

5.5. Greater action is needed to build resilience of critical infrastructure to intensifying natural hazards and man-made threats.

One of the key focus areas when building EU resilience to disasters is the resilience of critical infrastructure that provides society with vital services (e.g. energy, water, food, communications, transport and healthcare). Natural hazards, accidents, terrorist attacks and cyberattacks can all disrupt the provision of these essential services. As the threats to critical infrastructure are increasing, our dependence on vital services and vulnerabilities are also increasing, not least due to the growing complexity and interconnectedness of modern critical infrastructure networks.

This rapidly evolving field requires revisiting EU legislation on the protection of critical infrastructure, which dates back to 2008. In 2019, the review of Directive No 2008/114/EC on the identification and designation of European Critical Infrastructures[221] was finalised. It concluded that, although the Directive had brought added value, it was no longer entirely relevant in the changed context and needed to be updated. To this end, the Commission will table a new proposal for additional measures on critical infrastructure protection before the end of 2020. This proposal will address the gaps identified in the review of the Directive, it will put a greater emphasis on resilience and interdependencies of critical infrastructure and it will take into account recent developments in related EU policy areas, such as civil protection.

5.6. Financial resilience to disasters should be increased, given the rising economic cost of disasters.

Currently, governments (and taxpayers) across the EU shoulder the majority of the cost of disaster response and recovery as only a third of losses caused by catastrophic events are insured. This 'protection gap' varies widely between countries and hazards, meaning that the degree to which people are covered by private catastrophe insurance products differs across Member States. In addition to differences in access to disaster insurance products, there are also challenges related to insufficient public awareness of risk and insurance products as well as their willingness to purchase insurance cover.

In the meantime, the frequency and economic costs of extreme events are on the rise. The European Insurance and Occupational Pensions Authority (EIOPA) has warned that in future, people's ability to access and to afford insurance against intensifying hazards could become a problem. [222] Where people and businesses are not covered by private insurance, post-disaster recovery and reconstruction work will require increased government expenditure, while effects on production capacity are likely to

[219] COM(2020) 220 final.

[220] COM(2020) 456 final.

[221] Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection (Text with EEA relevance), OJ L 345, 23.12.2008, p. 75–82.

[222] European Insurance and Occupational Pensions Authority. Discussion paper on the protection gap for natural catastrophes, 2019. Available at https://www.eiopa.europa.eu/content/discussion-paper-protection-gap-natural-catastrophes_en.

result in an economic slowdown, reduced budget revenue and increased expenditure on welfare. Furthermore, losses to public assets are seldom insured, putting an additional strain on public budgets. Against this backdrop, effective financial management of disaster risks is an important public policy priority that requires the input of robust assessments of disaster risks and impacts.[223] Collecting better data on disaster loss for both the private and the public sector is the first step towards building a stronger financing strategy for disaster risk management.

From a budgetary perspective, disaster risk financing strategies must be country-specific and build on a combination of budgetary resources and risk sharing instruments adapted to the severity and frequency of disasters. Transferring risk to private insurance companies can benefit the public budget, which would have to carry a lighter burden of damage caused by disasters. Public authorities can take action to increase the insurance coverage for catastrophes caused by natural hazards, for example via taxation or public-private partnerships. They should give incentives for risk transfer mechanisms, in particular for low likelihood, high-impact disasters. However, it has to be acknowledged that not all risks are (fully) insurable by private insurers. Moreover, although a higher take-up of risk transfer mechanism tools is potentially beneficial to private and public bodies, the tools should be carefully designed to ensure that they do not become a disincentive for implementing adaptation measures and do not undermine action to reduce long-term vulnerability. Dialogue between the insurance industry, consumers, businesses and public authorities can help understand potential problems and design solutions.

5.7. Improving the evidence base is key to effective risk management and to building resilience.

Not only risk financing strategies, but all risk management actions must be underpinned by solid and up-to-date knowledge of disaster risks and their impacts. Although the science, the risk assessments and risk data have gradually improved, ongoing action is needed to further build up the evidence base for risk management in Europe.

Given the complexity and the systemic nature of disaster risk, it is important that risk assessments are based on an all-hazards and a cross-sectoral approach. They should also provide a solid qualitative and quantitative assessment to feed into the policy response.

Scarce and fragmented data on exposure and disaster loss remains one of the biggest obstacles to framing risk-informed policies at national and European levels. Recording, collection and access to data should therefore be improved. Given these persistent shortcomings, provisions on more systematic collection and dissemination of disaster loss data have been included in several recently adopted and newly proposed EU legal instruments[224], including the 2020 proposal to revise the UCPM[225]. Working to obtain better and more data on climate change impacts will be a priority under the EU's new adaptation strategy to be adopted in 2021.

In addition to having better (historical) data, it is essential to further develop the forward-looking perspective of risk assessments. This will enable a better understanding and preparedness for the impacts of climate change and will also detect developments that could have significant implications for disaster risk in future, but that are not yet on the policy radar.

The next edition of risk assessments should be used to support Member States and the EU in building resilience to future shocks and large-scale disasters. The Commission's 2020 proposal to revise the UCPM proposes carrying out collective and cross-sectoral work to develop EU resilience goals and planning for natural and man-made disasters likely to have a transboundary effect. This work will have to be based on data on past events and forward-looking scenarios and take into account the adverse effects of climate change. [226]

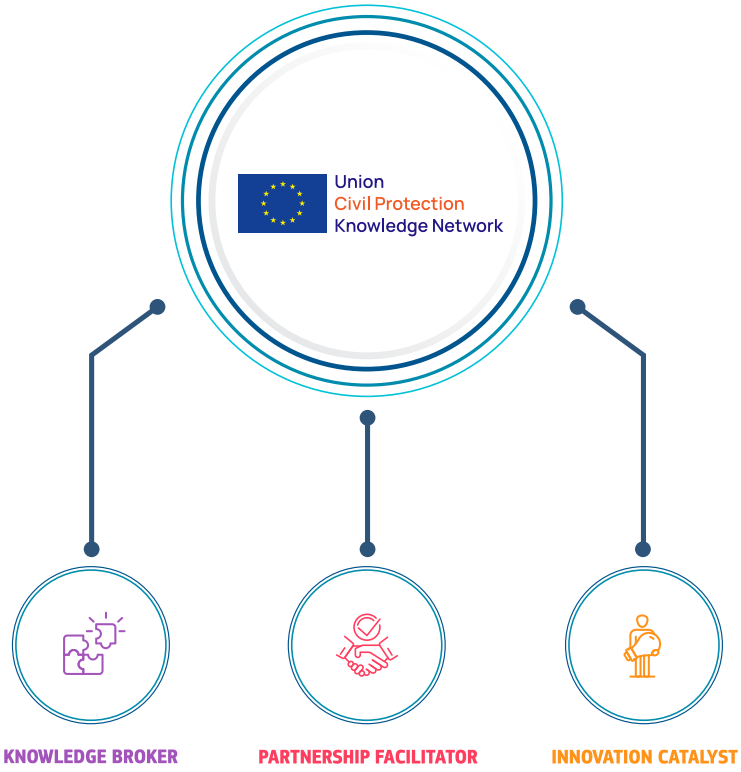
[223] G20/OECD methodological framework on disaster risk assessment and risk financing, 2012. Available at https://www.oecd.org/gov/risk/g20oecdframeworkfordisasterriskmanagement.htm.

[224] E.g. Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, the Sustainable Finance Action Plan, the Commission's proposal on the Climate Law, COM(2020) 80 final.

[225] COM(2020) 220 final.

[226] Idem.

The EU offers a number of tools to support the work on strengthening the knowledge basis for disaster risk management. These include the DRMKC and its Risk Data Hub, the Union Civil Protection Knowledge Network, the Copernicus Earth Observation programme, and the community of users on safe, secure and resilient societies. Member States are encouraged to make use of these initiatives and work together with the Commission to develop them further to make sure they respond to their needs.



The Union Civil Protection Knowledge Network connects civil protection and disaster management communities, sharing knowledge and growing collective strength in prevention of, preparedness for and response to disasters.

Connect. Share. Grow.

ANNEX 1. THE OVERVIEW OF SELECTED DISASTER RISKS IN THE EU

1. Extreme weather

1.1. The risk and trends

The climate in Europe varies from maritime to polar and can be split into four main groups: subtropical, temperate, cold, and circumpolar. The different climatic conditions across the continent mean that Europe faces a variety of different extreme weather risks, from storms and heavy precipitation to heatwaves.

Extreme weather events frequently occur in Europe and have significant human and economic consequences. The impacts differ depending on the type of extreme weather event: for example, heatwaves predominantly impact on humans, while storms and heavy precipitation lead to a high level of economic damage. Between 1980 and 2017, weather and climate-related extremes caused 87 391 fatalities across the EU, up to 77 637 of them due to heatwaves, the majority a result of the 2003 heatwave. Based on data in the NatCatSERVICE database, in the same period, extreme weather events led to economic losses of EUR 426 billion, with storms alone causing EUR 163 billion in damages *(Figure 22)*[227].

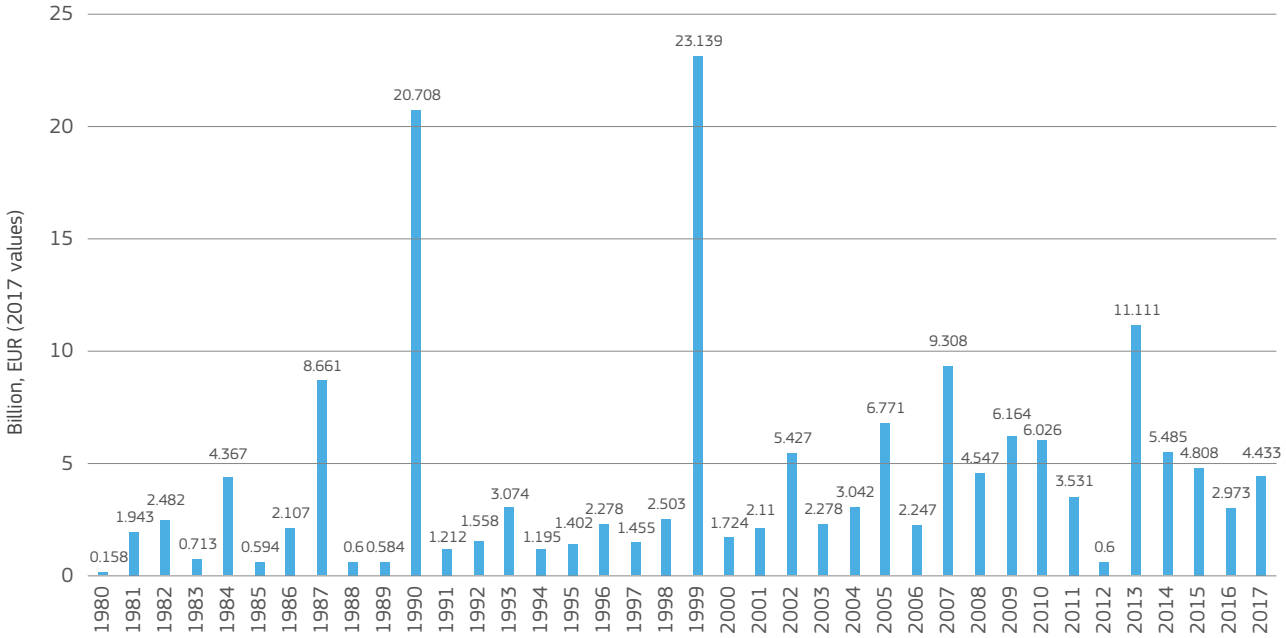


Figure 22. Economic losses caused by storms in the EU-28, 1980-2017. Source: MunichRe/EEA[228]

The distribution of losses among the EU Member States is uneven. The PESETA IV study estimates that absolute losses from windstorms are highest in Germany (EUR 850 million/year), France (EUR 680 million/year), Italy (EUR 540 million/year) and the UK (EUR 530 million/year), while impacts relative to the size of the economy are double the EU average in Bulgaria and Estonia (0.08% of GDP) and in Latvia, Lithuania and Slovenia (0.07% of GDP)[229].

[227] Economic losses from climate-related extreme weather events in Europe. The European Environment Agency collects information on fatalities and economic losses from disasters caused by natural hazards. The data is provided by the NatCatSERVICE of the Munich Reinsurance Company. Available at https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2

[228] Idem.

[229] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

Box 14. Extreme weather disasters 2017–2019

- An intense outbreak of cold weather with very low temperatures and locally intense precipitation (rainfalls/snowfalls), dubbed 'the Beast from the East', affected most of Europe at the end of February 2018, causing dozens of deaths and major disruptions to infrastructure[230] [231]. The interaction of Anticyclone Hartmut and Cyclone Emma intensified the wind and snowfall in Western Europe.
- Europe saw extreme heatwaves in 2017, 2018 and 2019. Though systematic data on the impacts of these events is not yet available, there are indications that they caused hundreds of premature deaths. For example, the French Ministry of Health reported 1 435 deaths linked to the 2019 summer heatwave[232], while the National Statistics Bureau of the Netherlands estimated that 2019 heatwaves caused nearly 400 premature deaths[233].
- Italy, France and Greece were affected by severe weather in November 2019, resulting in fatalities and material damage. In Italy heavy rain, strong winds, storm surges and snow caused river overflow, snow avalanches, flooding and landslides. Roads and highways were damaged and one bridge on the Torino-Savona highway collapsed following a mudslide[234].

Storms, strong wind and hurricanes

Windstorms are characterised by continuous strong winds and are often accompanied by intense precipitation. Large storms in mainland Europe are extra-tropical cyclones (or hurricanes). In northern and north-western Europe, severe cyclones can take place throughout the whole year, while in central Europe, they occur mainly in autumn and winter. Regions closer to the coast are particularly vulnerable[235]. The EU's outermost regions[236] are affected by tropical cyclones, which can be particularly damaging, as seen in September 2017 when category 5 hurricanes Irma and Maria caused massive devastation in the French Caribbean outermost regions of Saint-Martin, Guadeloupe and Martinique.

In terms of knock-on or concurrent events, storms, especially when combined with heavy precipitation, may lead to floods, storm surges and coastal erosion and can cause serious risks to health, transportation and infrastructure. Coastal storms are also addressed under Section 2 of this Annex in relation to coastal flooding. In terms of changes in frequency or severity of storms, historical trends vary substantially and therefore no significant long-term trends are apparent.

Heatwaves and cold waves

The length, intensity, and frequency of heatwaves in Europe is rising. A heatwave is generally defined as a period of excessively hot temperatures, lasting for several days. The severity of a heatwave depends on a number of factors, including its duration, its relative intensity (how much hotter than normal) and its absolute intensity. Extreme temperatures are often connected to droughts, as dry soil reduces evaporative cooling[237] and thus increases the scale of a heatwave[238]. Heatwaves can also worsen droughts as they exacerbate soil moisture deficits and low flows in rivers. Extreme heat can also conversely be linked to the increased frequency and intensity of heavy

[230] 'Over 40 people have died as a result of the severe icy weather gripping Europe', thejournal.ie, 28 February. Available at 2018 https://www.thejournal.ie/europe-beast-from-the-beast-3877165-Feb2018/

[231] Copernicus. 'Cold start to the year', Climate in 2018. Available at https://climate.copernicus.eu/cold-start-year

[232] 'Le ministère des Solidarités et de la Santé. Impact sanitaire modéré des canicules de l'été 2019 sur les chiffres de la mortalité.' 8 September 2019. Available at https://solidarites-sante.gouv.fr/actualites/presse/communiques-de-presse/article/impact-sanitaire-modere-des-canicules-de-l-ete-2019-sur-les-chiffres-de-la

[233] Reuters. 'Heatwave caused nearly 400 more deaths in Netherlands: stats agency', August 9, 2019. Available at https://www.reuters.com/article/us-weather-netherlands/heatwave-caused-nearly-400-more-deaths-in-netherlands-stats-agency-idUSKCN1UZ0GA?il=0

[234] 'Flooding in France, Italy, Greece Kills 9, Causes Highway to Collapse', by The Associated Press, 25 November 2019. Available at https://weather.com/news/news/2019-11-24-france-italy-deadly-flooding-highway-collapse

[235] The European Environment Agency. 'Climate change adaptation and disaster risk reduction in Europe: Enhancing coherence of the knowledge base, policies and practices'. EEA Report No. 15/2017. Available at https://www.eea.europa.eu/publications/climate-change-adaptation-and-disaster

[236] Guadeloupe, French Guiana, Martinique, Saint Martin, Réunion, Mayotte (France); the Canary Islands (Spain); and the Azores and Madeira (Portugal).

[237] Evaporative cooling is the conversion of liquid water into vapour using the thermal energy in the air, resulting in a lower air temperature.

[238] Mueller, B. and Seneviratne, S. I., 2012, 'Hot days induced by precipitation deficits at the global scale', Proceedings of the National Academy of Sciences 109(31), 12398–12403 (DOI: 10.1073/pnas.1204330109).

precipitation events (including hailstorms); warmer air can hold a greater quantity of water[239].

People in the EU are particularly vulnerable to heatwaves as three quarters of the EU-28 population lives in urbanised areas[240]. The 'urban heat island' effect, caused by the built environment absorbing more heat than its rural surroundings, exacerbates the impacts of heatwaves. Cities in central and north-western Europe are being increasingly affected[241], worsened by built environments that are not adapted to such temperature extremes. Additionally, having a high proportion of elderly people makes cities sensitive to heatwaves and other climatic hazards. In addition to the elderly, those with chronic diseases and disadvantaged groups also have a heightened risk of heat-related mortality.

In terms of impacts on life and health, there is some debate over whether extreme highs are more dangerous than extreme lows. Figure 23 shows the number of fatalities due to extreme temperatures in European countries between 1990 and 2016. The number of fatalities in that period due to the heat was heavily affected by the heatwaves of 2003. The number of fatalities due to the cold includes both victims of 'cold waves' and 'extreme winter conditions'.

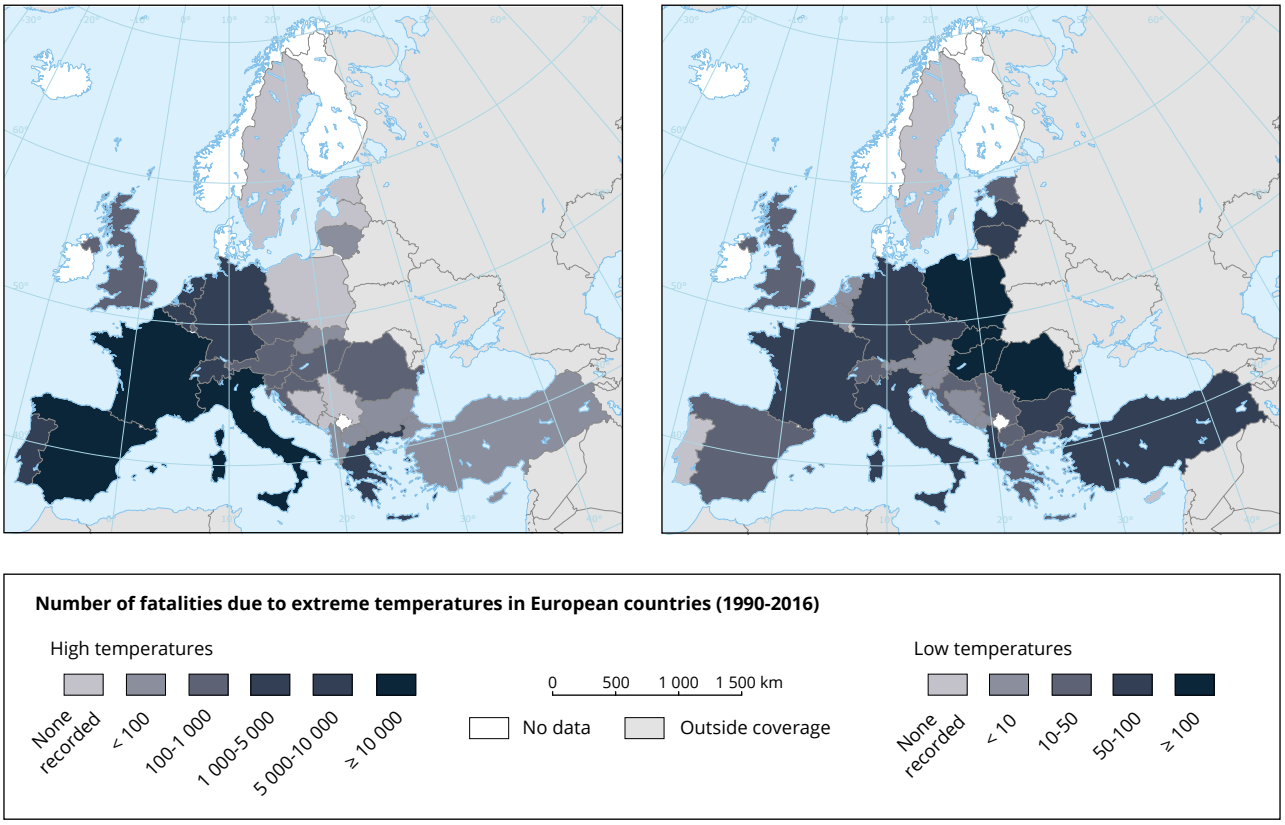


Figure 23. Number of fatalities due to extreme temperatures 1990-2016. Source: EEA[242]

[239] Kendon, E. J., Roberts, N. M., Fowler, H. J., Roberts, M. J., Chan, S. C. and Senior, C. A., 2014, 'Heavier summer downpours with climate change revealed by weather forecast resolution model', Nature Climate Change 4(7), 570–576 DOI: 10.1038/nclimate2258.

[240] European Union and United Nations Human Settlements Programme (UN-Habitat). The State of European Cities 2016. Cities leading the way to a better future, ISBN Number: (Volume) 978-92-79-64260-9 | doi:10.2776/770065 Luxembourg: Publications Office of the European Union, 2016.

[241] The European Environment Agency. Climate change, impacts and vulnerability in Europe. An indicator-based report. EEA Report No. 1/2017. Available at https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016

[242] The European Environment Agency. Unequal exposure and unequal impacts: social vulnerability to air pollution, noise and extreme temperatures in Europe. Report No 22/2018. Available at https://www.eea.europa.eu/publications/unequal-exposure-and-unequal-impacts

Temperature extremes can disrupt critical infrastructure networks, particularly transport and energy supply. Extreme heat is detrimental to water availability and consequently the energy sector, which depends on a secure water supply for cooling and for energy production. The repeated heatwaves of 2019 across Europe, with record-breaking temperatures, led to several nuclear power plants in various parts of Europe temporarily closing and affected hydropower output and stocks in France, Spain, the Balkans and Scandinavia. Existing transport networks (roads, railways and bridges) are also vulnerable to heatwaves, particularly in southern and eastern Europe, as they are not designed to withstand extreme heat, while still being faced with cold conditions in the winter in some places. Transport infrastructure in northern Europe is in turn affected by cold spells and snow[243].

Heavy precipitation (snow, snowstorms, hail, rain)

The intensity of heavy precipitation events, both in summer and winter, have increased in northern and north-eastern Europe since the 1960s. However, different studies and indices show diverging trends for south-western and southern Europe[244]. Heavy precipitation events have considerable impacts on society, including agriculture, industry and ecosystem services[245]. Hail events in particular are among the most costly weather-related extreme events in several European regions, causing substantial damage to crops, vehicles, buildings and other infrastructure. The highest number of hail events occur in mountainous areas and pre-Alpine regions. However there have been increases in hail in southern and central Europe, particularly in southern France, northern Italy and Austria. This is due to a warming and more unstable atmosphere[246]. In terms of concurrent or cascading risks, heavy precipitation can lead to floods and thus is also addressed in the following section on flooding.

1.2. Key risk drivers

Climate change is already affecting the frequency and severity of extreme weather events, and this trend is projected to increase. One of the key climate change signals is extreme heat. The hottest summers in Europe over the past 500 years have all come in the past 17 years. As the planet continues to warm, the whole of Europe will be affected by more frequent and longer periods with extreme high temperatures[247]. Figure 24 shows the change in annual average temperature across Europe between the reference period (1981-2010) and the three warming scenarios. It reveals that the magnitude of warming in Europe is greater than the global average. It is also not uniform across the continent, with northern Europe and parts of southern Europe showing increased warming.

[243] Idem.

[244] Idem.

[245] Ecosystem services are the benefits that people obtain from ecosystems. In other words, ecosystem services are the direct and indirect contributions of ecosystems to human wellbeing. These services include provisioning, regulating, cultural and supporting services on which societies and economies depend, including food and water provision, climate regulation, flood control, air and water purification, erosion control, etc. Source: European Commission. Mapping and Assessment of Ecosystems and their Services. April 2013. Available at doi: 10.2779/12398

[246] The European Environment Agency. Climate change adaptation and disaster risk reduction in Europe: Enhancing coherence of the knowledge base, policies and practices. EEA Report No. 15/2017. Available at https://www.eea.europa.eu/publications/climate-change-adaptation-and-disaster

[247] Idem.

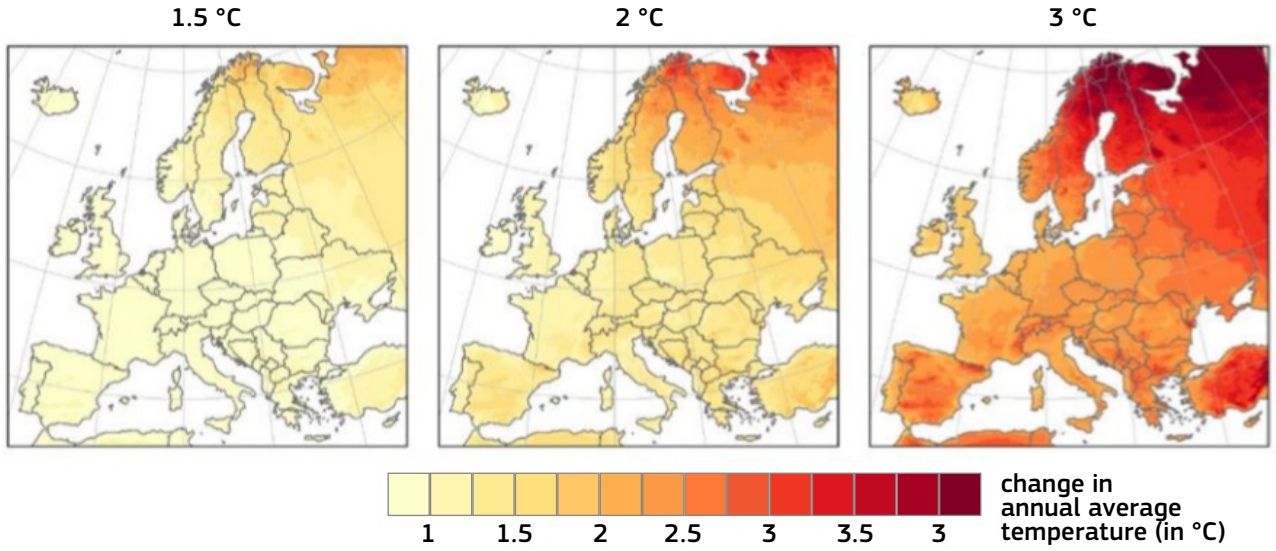


Figure 24. Changes in annual average temperature comparing the reference (1981-2010) and three global warming scenarios (1.5°C, 2°C and 3°C). Source: PESETA IV[248]

With climate change, heatwaves are expected to happen more frequently and become more intense. In a climate that is 3°C warmer compared to pre-industrial times, a current 50-year heatwave may occur almost every year in southern Europe, whereas in other regions of Europe such events may happen every 3 to 5 years.[249]

The projected changes in the heatwave hazard leads to a large increase in the number of people exposed to extreme heat as well as mortality (*Figure 25*). This increase is most pronounced in southern European countries and the highest number of fatalities are predicted to occur in France, Italy and Spain[250]. On the other hand, the exposure to and number of fatalities associated with extreme cold spells are expected to decrease because of milder winters[251] and better social, economic and housing conditions in many EU countries.

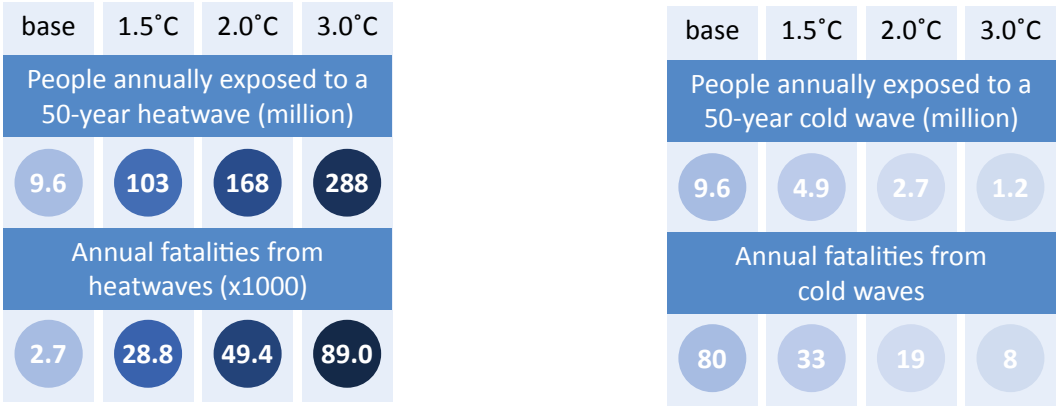


Figure 25. Human exposure to and fatalities from heatwaves and cold waves in Europe. Source: PESETA IV[252]

[248] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

[249] Idem.

[250] Idem.

[251] Idem.

[252] Idem.

Regarding precipitation, moderate changes are projected in the 2°C global warming scenario. However, with 3°C global warming, more significant differences are expected, with increases in north-central-eastern Europe and a decline in most parts of the Mediterranean (*Figure 26*). Winters will generally be wetter in most of Europe, except for its most southern parts where reductions of up to 25% in winter precipitation are projected. Southern Europe is also expected to see a decline in summer precipitation. The latter trend can also affect western Europe and parts of central and eastern Europe, despite the overall increase in annual average precipitation in these regions[253]. The impacts of climate change on hail are more difficult to predict, as the trends and projections of hail events are still subject to a high degree of uncertainty.

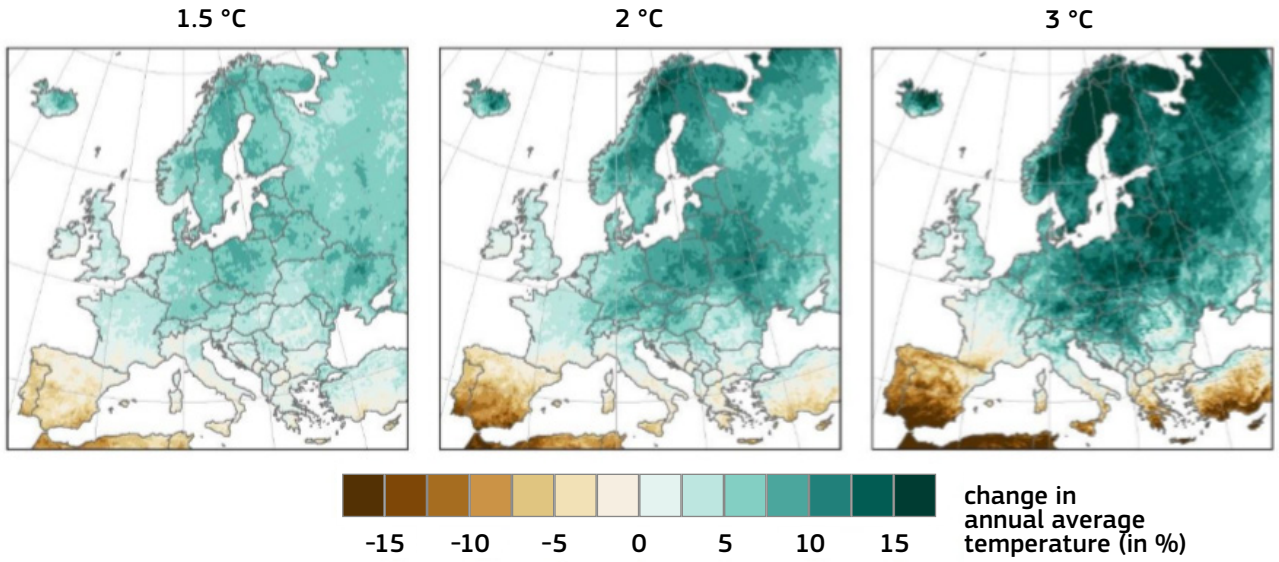


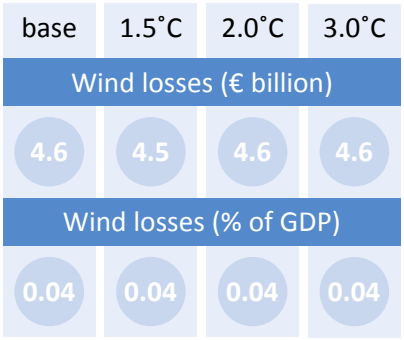
Figure 26. Changes in annual average precipitation comparing the reference (1981-2010) and three global warming scenarios (1.5°C, 2°C and 3°C). Source: PESETA IV[254]

Despite the recent advances in climate modelling techniques, there are many uncertainties in predicting future storm trends due to knowledge gaps around storm formation and incomplete historical records. Nevertheless, there is general agreement on the fact that over the 21st century the strongest, most devastating storms are likely to increase, both in autumn and winter, in most European regions, particularly in the North Atlantic region and in northern, north-western and central Europe. Recent studies on changes in winter storm tracks generally project that the North Atlantic storm track will extend eastwards towards central Europe and Britain and Ireland[255]. Mediterranean Sea hurricanes (otherwise known as 'medicanes') are predicted to decrease in frequency but increase in intensity in the Mediterranean area.

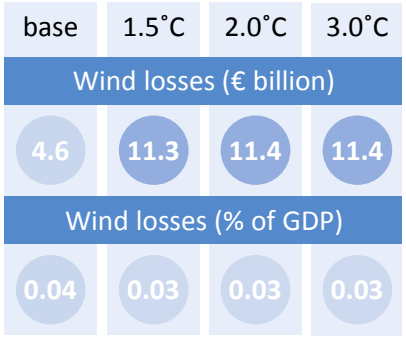
[253] Idem.

[254] Idem.

[255] The European Environment Agency. Climate change, impacts and vulnerability in Europe. An indicator-based report. EEA Report No. 1/2017. Available at https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016



Average annual wind losses for the EU and UK assuming that current socioeconomic conditions continue into the future



Average annual wind losses for the EU and UK assuming socioeconomic conditions in 2100 according to the 2015 Ageing Report[256]

Figure 27. Average annual wind losses for the EU and UK. Source: PESETA IV[257]

The effects of extreme weather events are determined not only by the severity of the event but also by the exposure and vulnerability of the population and economic assets. Looking forward, the continued trend of population ageing in Europe is a vulnerability factor that could aggravate the effects of extreme weather events, in particular extreme temperatures. Further, continued urbanisation could amplify the urban heat island effect. The combined effects of heatwaves and air pollution might further exacerbate human stress in densely populated areas. All EU capital cities will become more vulnerable to extreme heat in the coming decades. The cold wave hazard may remain a significant threat locally in certain regions[258].

[256] The economy of the future based on 2015 Ageing Report projections of population and economy. The European Commission. The 2015 Ageing Report. Underlying Assumptions and Projection Methodologies. EUROPEAN ECONOMY 8/2014.

[257] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

[258] Smid, M. et al. Ranking European capitals by exposure to heat waves and cold waves. Urban Climate (27), March 2019, pp 388-402. https://doi.org/10.1016/j.uclim.2018.12.010

1.3. Extreme weather in national risk assessments

Extreme weather risk in NRAs 2015

Extreme weather risk in NRAs 2018/2019

Each extreme weather event, from heatwaves to sleet to cyclones, has different characteristics and therefore should be analysed separately. This approach is taken in the majority of national risk assessments that consider extreme weather. Storms/strong wind/hurricanes are the most common types of extreme weather, included by all but three countries that assessed extreme weather in their national risk assessments. This is followed by snow/snowstorms/hail, which some countries combine with low temperature. Heatwaves and cold waves were included by almost half of the countries that assessed extreme weather. Five countries assessed the risk of extreme rain in addition to the risk of flooding (see section 2.1 on flooding). Some rarer risks, assessed in only a few national reports, include ice, sleet, extreme fog, cloud inversions and tropical cyclones (relevant only for the French overseas territories).

Generally, extreme weather events are assessed as being highly likely by all Member States that included these risks, but the level of impact varies from the being the highest on the scale to mid-range. The level of impact depended on the specific risk in question; most often heatwaves were on the upper end of the impact scale and storms in the mid-range. There has been little change compared to the 2015 national risk assessments, except for five Member States that added more types of extreme weather or for whom extreme weather was added as a new risk entirely. For one Member State, the likelihood of cold-weather related risks decreased due to the impacts of climate change.

While Member States generally consider the influence of climate change on the risk of extreme weather, for storms the impact of climate change is rarely taken into account or is assessed as negligible. This is due to the lack of accurate data on storm behaviour and poor representation of storms in climate models. Cascading effects of extreme weather were included by some countries. Most often these were disruptions to critical infrastructure:

- transport networks (road, rail, aviation, maritime);
- telecommunication networks;
- electricity networks, leading to power outages with knock-on effects on the provision of food and medical supplies; and
- disruptions to sewage systems and water supplies.

Secondary hazards were also sometimes considered:

- flooding, forest fires, pests in forests, chemical contamination, and landslides as a result of storms;

- floods, epidemics, epizootics, chemical contamination, landslides and snow avalanches as a result of intense precipitation; and
- droughts and forest fires as a result of heatwaves.

1.4. Addressing the risk: EU actions

The Union Civil Protection Mechanism (UCPM) was only on stand-by once, without being activated, for extreme weather between 2017 and 2019. However, the EU Solidarity Fund was mobilised on four occasions in response to hurricanes and other severe weather events, such as:

- in the aftermath of Hurricanes Irma and Maria that devastated France's outermost regions (Saint-Martin, Guadeloupe, Martinique) in 2017;
- after Hurricane Lorenzo that hit Portugal's outermost region of the Azores in 2019;
- after a storm in Poland in 2017; and
- to help Greece deal with damages inflicted by severe weather in 2019.

The European Regional Development Fund (ERDF) and Cohesion Fund provide significant funds for investments in preventing and preparing for extreme weather events in Member States, as well as for cross-border and transnational cooperation in this area.

The common agricultural policy (CAP), through the European Agricultural Fund for Rural Development (EAFRD), offers a safety net for farmers who have to deal with unpredictable events such as extreme weather phenomena. These risk management tools include financial contributions to insurance premiums and support to mutual funds covering farmers' production losses due to, for example, adverse climatic conditions and an income stabilisation tool providing compensation to farmers for a severe drop in their income. The EAFRD also provides financial support to farmers to restore the potential for agricultural production, which is damaged by natural disasters, and to introduce appropriate preventive measures designed to reduce the consequences of natural disasters. Similar measures are available for forest holders, both for preventing damages and restoring forests after a natural disaster.

Risk and loss assessment of windstorms is being improved through the Copernicus Windstorm Information Service (WISC)[259], a tool developed by the European Commission's Copernicus Climate Change Service for the insurance and reinsurance industry which can access a high-quality dataset of windstorm information at a range of scales within Europe.

The EU adaptation strategy, adopted in 2013, aims to step up the preparedness and capacity of all governance levels to respond to the impacts of climate change, including more extreme weather events.

Building stronger links between climate change adaptation and disaster risk reduction is more important than ever in wake of recent devastating and extreme weather events across Europe and elsewhere. Closer cooperation, including better policy alignment, will be crucial to reducing the impacts of weather- and climate-related hazards. Climate change adaptation helps countries prepare for increasingly frequent and extreme heatwaves. In particular, providing more green space helps to cool down city centres while bringing health and quality of life benefits to urban residents.

2. Flooding

2.1. The risk and trends

About 1.2 million kilometres of rivers and more than 18 000 lakes exist in the EU. There are 177 river basin districts in the EU, of which 94 lie across country borders[260]. The Danube, for example, has a catchment shared by 19 countries in central Europe, the Balkans and the EU's eastern neighbourhood. Countries with long coastlines tend to have relatively smaller river catchments and shorter rivers, and their populations tend to be located in towns along the coast. Overall, nearly half of the EU population lives within 50 kilometres of the coast. On the other hand, most European cities have at least one river or lake crossing their urban landscape

[259] Available at https://wisc.climate.copernicus.eu/wisc/#/

[260] SWD(2019) 30 final.

while roughly three quarters of the total EU-28 population live in cities, towns and suburbs[261]. Considering this proximity to water, flooding remains as one of most frequent and economically damaging disasters in the EU.

Flood events occur in Europe most commonly in the form of:

- river, or fluvial, flooding;
- coastal flooding and storm surges; and
- pluvial flooding, which can take the form of flash floods in urban areas.

In mountainous or hilly areas, secondary or associated hazards include landslides as both flooding and landslides events can be caused by heavy rainfall.

River and coastal flooding has affected millions of people in Europe. Since 1870, there has been an increase in the area flooded annually and the number of people affected, although this is contrasted by a substantial decrease in flood fatalities[262]. While floods result in comparatively lower numbers of fatalities compared to other natural hazards, they can still be lethal. Between 1980 and 2017, more than 3 000 people lost their lives in floods. In addition to fatalities, floods also cause many negative effects on people's health, including injuries, infections, exposure to chemical hazards and mental health problems[263].

The economic impact is also substantial, though estimations vary. Based on data in the NatCatSERVICE database, over 1980-2017, hydrological events (floods and landslides) have caused a total of EUR 159.55 billion in damages across the EU-28[264] or on average EUR 4.3 billion/year[265] (*Figure 28*). However, PESETA IV estimations suggest that the economic losses caused by flooding events could be much higher, reaching on average EUR 7.8 billion/year for river flooding and EUR 1.4 billion/year for coastal floods[266]. Besides economic losses, flooding events can lead to disruption of critical services, including health services, safe water, sanitation and transportation.

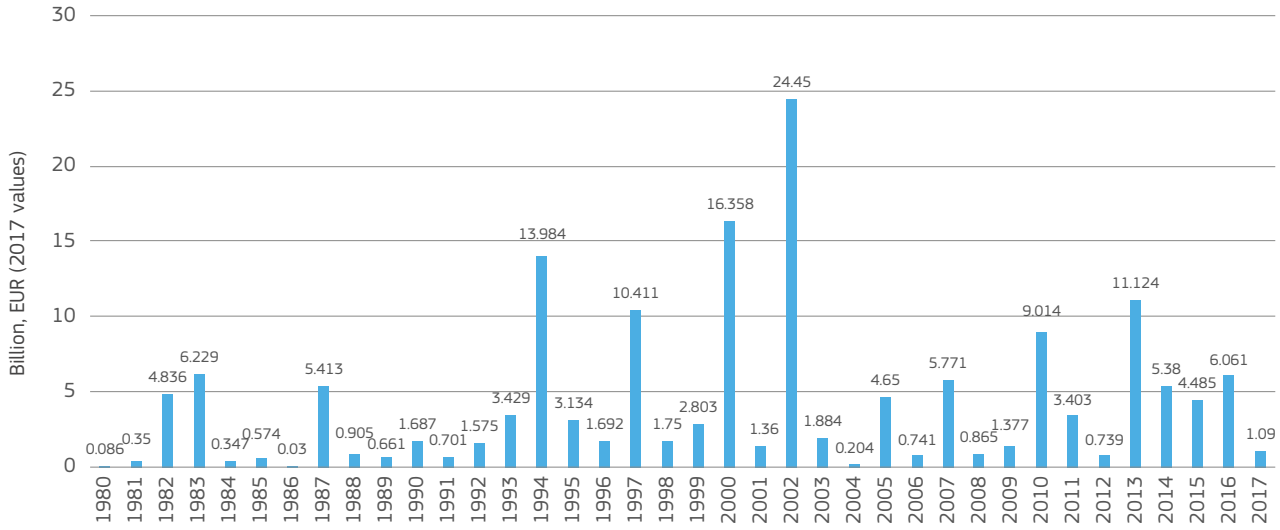


Figure 28. Economic losses caused by floods and mass movement in the EU-28, 1980-2017. Source: MunichRe/EEA[267]

[261] EUROSTAT, 2015, quoted in 'Rivers and lakes in European cities: Past and future challenges', report by the European Environment Agency, 2016, P.8.

[262] Paprotny, D., Sebastian, A., Morales-Nápoles, O. *et al.* Trends in flood losses in Europe over the past 150 years. *Nat Commun* **9,** 1985 (2018). https://doi.org/10.1038/s41467-018-04253-1.

[263] The European Environment Agency. Climate change, impacts and vulnerability in Europe. An indicator-based report. – EEA Report No. 1/2017. Available at https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016

[264] Economic losses from climate-related extremes in Europe. The European Environment Agency collects information on fatalities and economic losses from disasters caused by natural hazards. The data is provided by the NatCatSERVICE of the Munich Reinsurance Company. Available at https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2

[265] Expressed in 2017 euro values.

[266] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

[267] Idem.

Box 15. The flooding extremes 2017–2019

- In November 2017, catastrophic floods in western Attica, Greece, killed more than 20 people, and caused injuries and damage to homes and infrastructure[268].
- In September 2017, heavy rainfall of almost 280 mm in 24 hours fell in Zadar, Croatia, causing damaging floods in the city. This was more than twice the amount of rain that usually falls in Zadar over the entire month of September[269].
- October and November 2019 were the worst months in terms of number of notifications issued since the beginning of the European Flood Awareness System (EFAS)[270] in 2012. In total there were 54 formal, 39 informal and 587 flash flood notifications issued during the period. Most of them were in November and in southern Europe, which was hit by a series of storms and floods during this period, with Italy, southern Spain and southern France in particular badly affected[271].

River floods

River floods are a common natural disaster in Europe, and – along with storms – are the most significant natural hazard in terms of economic damage. As mentioned, the PESETA IV study estimates that on average, river flooding causes EUR 7.8 billion of economic losses per year[272]. The number of very severe river flood events in Europe increased over 1985–2016[273], but with large variability between the years in question. This increase has been attributed to better reporting, land-use changes and increased heavy precipitation in parts of Europe, but it is not currently possible to quantify the importance of these factors[274]. Additionally, there has been an increase in economic losses from river flooding since the 1970s. This trend can be attributed to socioeconomic factors, such as increasing wealth located in flood zones. Increases in heavy precipitation in parts of Europe may also play a role.

Coastal floods and storm surges

Nearly half of the EU's population lives less than 50 km from the sea; the majority is concentrated in urban areas along the coast[275]. Coastal flooding has had an impact on low-lying coastal areas in north-western Europe in the past. Most often, it is caused by a combination of storm surge and high tidal levels, which lead to extremely high water levels along the coast. The most intense surge events typically occur during winter in Europe and are caused by coastal storms (storms have also been covered under section 1 and are considered as extreme weather events). Extreme high coastal water levels have increased at most locations along the European coastline. This appears to be predominantly due to increases in mean local sea level[276]. This trend in turn has increased the risk of coastal flooding. The PESETA IV study estimates the economic losses in the EU from coastal flooding to be on

[268] R.Davies. Case study: Floods in the Attica Region, Greece, November 2017. 22 November 2017 – available at https://www.efas.eu/en/news/case-study-floods-attica-region-greece-november-2017

[269] R.Davies. Croatia – Floods in Zadar after 280 mm of rain in 24 hours. 12 September 2017 – available at http://floodlist.com/europe/croatia-floods-zadar-september-2017

[270] The aim of the EFAS is to support preparatory measures before major flood events occur, particularly in the large transnational river basins and throughout Europe in general. For more details, visit www.efas.eu

[271] R.Davies. Southern Europe, October to November floods 2019. 17 December 2019 – available at https://www.efas.eu/en/news/southern-europe-october-november-floods-2019

[272] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

[273] European Academies' Science Advisory Council. Extreme weather events in Europe. Preparing for climate change adaptation: an update on EASAC's 2013 study. March 2018 – available at https://easac.eu/fileadmin/PDF_s/reports_statements/Extreme_Weather/EASAC_Statement_Extreme_Weather_Events_March_2018_FINAL.pdf

[274] The European Environment Agency. River floods – available at https://www.eea.europa.eu/data-and-maps/indicators/river-floods-2/assessment#tab-used-in-publications

[275] EUROSTAT. Coastal regions: people living along the coastline, integration of NUTS 2010 and latest population grid - Issue number 30/2013 – available at https://ec.europa.eu/eurostat/web/products-statistics-in-focus/-/KS-SF-13-030

[276] The European Environment Agency. Global and European sea-level rise. Available at https://www.eea.europa.eu/data-and-maps/indicators/sea-level-rise-6/assessment

average EUR 1.4 billion per year, with France and the UK accounting for half of this loss[277].

Pluvial flooding and flash floods

Pluvial flooding is the flooding of land directly from rainfall water falling on or flowing over it. A flash flood is a characteristic of a flood that rises and falls quite rapidly with little or no advance warning, usually as a result of intense rainfall over a relatively small area[278]. Since the 1960s, the intensity of heavy precipitation events in summer and winter has increased in northern and north-eastern Europe (this has also been addressed under section 1 on extreme weather phenomena). More extreme precipitation events combined with increasing soil sealing[279] due to urban sprawl have amplified the risk of urban flooding. In most cities, the level of soil sealing is between 40 and 60%, with some cities having soil sealing as high as 80%. This means excess water from extreme rainfall cannot drain into the ground and is instead led into sewage systems, which often are not designed to cope with such amounts of water[280].

Compound flooding

Compound flooding occurs when large run-off from heavy precipitation, leading to river flooding, is combined with high sea level (storm surge). Low-lying coastal areas are therefore at a particularly high risk. The resulting impact of the combined hazards can be worse than when they occur individually[281]. Nevertheless, they are rarely analysed as interacting phenomena. The recently released pan-European HANZE (Historical Analysis of Natural Hazards in Europe) database[282] lists 24 co-occurrences of storm surges and river floods along the Irish, UK, Belgian and Polish coasts, the French Atlantic and Mediterranean coast, and the Italian Adriatic coast. In the present climate, the highest compound flooding probability is concentrated primarily along the Mediterranean coast[283].

Floods can also occur as a result of the failure of infrastructure, notably hydropower dams or flood defences.

2.2. Key risk drivers

Increased flooding is likely to be one of the most serious effects from climate change in Europe over the coming decades. Trends that have been previously observed are continuing whereby climate-related extreme events are rising, with particularly sharp rises in hydrological events[284]. A high emissions scenario could lead to manifold increases in the socioeconomic impact of floods in Europe by the end of the 21st century, especially as regards damages from the coastal flooding *(Figure 29, Figure 31).*

[277] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

[278] The European Commission. Guidance for Reporting under the Floods Directive (2007/60/EC). Luxembourg: Office for Official Publications of the European Communities, 2013. - ISSN 1725-1087 ISBN 978-92-79-33168-8 doi: 10.2779/50095.

[279] Soil sealing is the covering of the soil surface with impermeable materials like concrete and stone, as a result of new buildings, roads, parking places and other public and private space. Depending on its degree, soil sealing reduces or completely prevents natural soil functions and ecosystem services on the area concerned.

[280] The European Environment Agency. Climate change, impacts and vulnerability in Europe. An indicator-based report. – EEA Report No. 1/2017. Available at https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016

[281] Bevacqua, E. et al. 2019. Higher probability of compound flooding from precipitation and storm surge in Europe under anthropogenic climate change. *Sci. Adv.* 5, eaaw5531.

[282] Paprotny, D., Morales-Nápoles, O., Jonkman, S. N., 2018. HANZE: A pan-European database of exposure to natural hazards and damaging historical floods since 1870. *Earth Syst. Sci. Data* 10, 565–581.

[283] Bevacqua, E. et al. 2019. Higher probability of compound flooding from precipitation and storm surge in Europe under anthropogenic climate change. *Sci. Adv.* 5, eaaw5531.

[284] European Academies' Science Advisory Council. Extreme weather events in Europe. Preparing for climate change adaptation: an update on EASAC's 2013 study. March 2018 – available at https://easac.eu/fileadmin/PDF_s/reports_statements/Extreme_Weather/EASAC_Statement_Extreme_Weather_Events_March_2018_FINAL.pdf

	Today	2100 - no adaptation			2100 - adaptation		
		1.5˚C	2˚C	3˚C	1.5˚C	2˚C	3˚C
Damage (€ billion/year)	7.8	24	33	48	8.6	9.6	8.6
People exposed (1000/year)	172	252	338	482	92	100	90

Figure 29. *River* flooding: annual damage and population exposed in the EU and the UK at present and by 2100, for different levels of global warming, with and without adaptation. Source: PESETA IV[285]

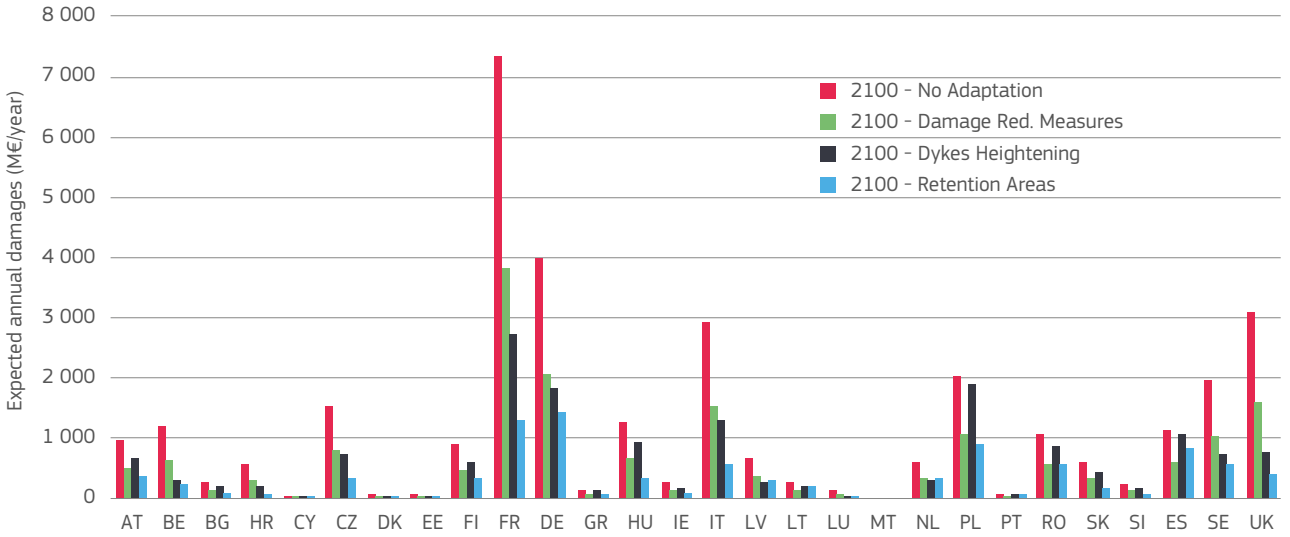


Figure 30. *River* flooding: comparison of expected annual damage in 2100 assuming no adaptation and with the implementation of adaptation strategies. Results are calculated assuming a 2°C warming scenario. PESETA IV[286]

For a number of European river basins, including the Po, Duero, Garonne, Ebro, Loire, Rhine and Rhone, an increase in extreme floods with a current return period[287] above 500 years is projected.

As mean sea levels and the intensity of storm surges are expected to rise in the coming decades, these factors are expected to increase the frequency of coastal flooding across EU coastlines[288]. Damage from coastal flooding is projected to rise sharply for all EU countries with a coastline and the UK if current levels of coastal protection are not raised. The largest absolute damage levels are projected for Germany, Denmark, France, Italy, the Netherlands and the UK. For some countries the damage represents a considerable proportion of future national GDP, e.g. 4.9% for Cyprus, 3.2% for Greece and 2.5% for Denmark by 2100 (high emissions scenario)[289].

[285] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

[286] Idem.

[287] Return period is a metric for the occurrence of natural hazards such as floods or earthquakes. It describes how likely a hazard event is to occur at, or above, a specific intensity within a time frame defined by a probability. A longer return period suggests a lower probability that an extreme hazard will occur in any single year. For example, the return period of a flood of 100 years can otherwise be expressed as its probability of occurring 1/100, or 1% in any one year. Source: Global Facility for Disaster Reduction and Recovery, https://www.gfdrr.org/en/100-year-flood

[288] The European Environment Agency. Climate change adaptation and disaster risk reduction in Europe: Enhancing coherence of the knowledge base, policies and practices. EEA Report No. 15/2017 – available at https://www.eea.europa.eu/publications/climate-change-adaptation-and-disaster

[289] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

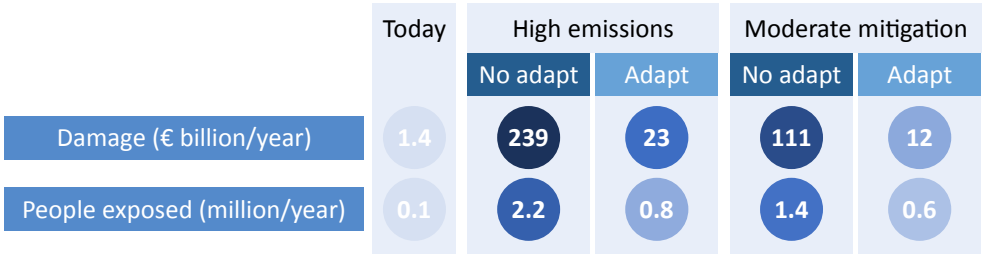


Figure 31. *Coastal* flooding: annual damage and population exposed in the EU and UK at present and by 2100, for different levels of global warming, with and without adaptation. Source: PESETA IV[290]

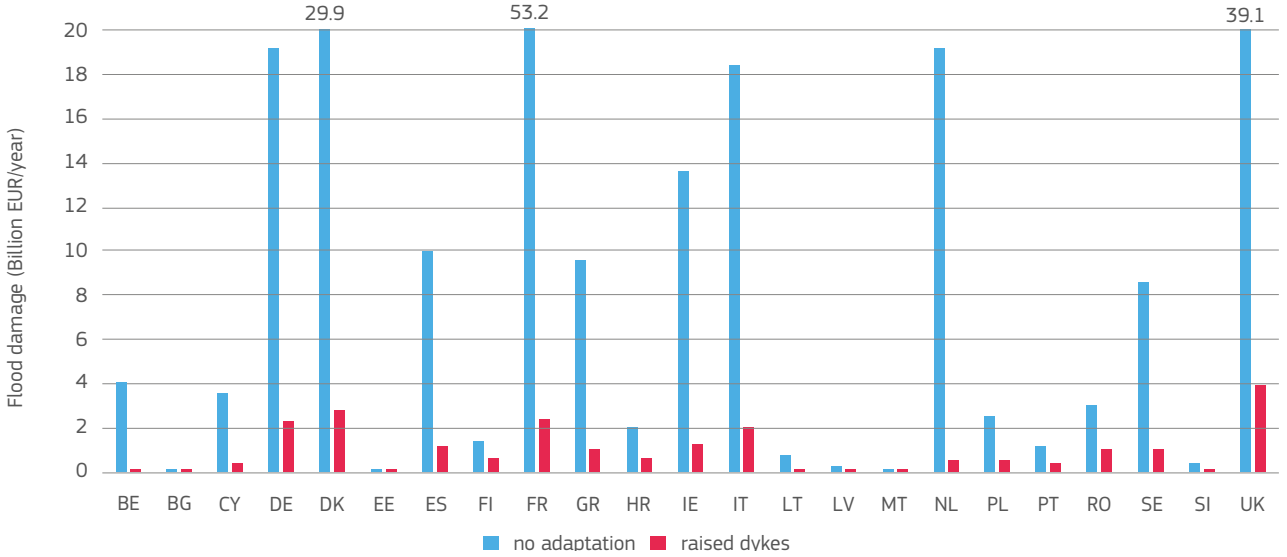


Figure 32. *Coastal* flooding: national annual damage without and with adaptation by 2100 (high emissions scenario). Source: PESETA IV[291]

Pluvial floods and flash floods are also likely to occur more frequently throughout Europe as they are triggered by intense local precipitation events, which are predicted to increase due to climate change[292]. The projected changes are strongest in Scandinavia and eastern Europe in winter[293]. Given that river flooding due to extreme precipitation as well as storm surges and sea levels are expected to increase as a result of climate change, it is likely that the likelihood of compound flooding will increase as well. The west coast of the UK, northern France, the coastlines of countries to the east and south of the North Sea, and the eastern half of the Black Sea are projected to be particularly affected[294].

While floods are a natural phenomenon, human choices have a significant effect on how often they occur and their impact. An increase in the likelihood and adverse impacts of flood events can result from building on floodplains or near the coast, the reduction of water-retaining surfaces, and interventions to watercourses or their surroundings.

[290] Idem.

[291] Idem.

[292] The European Environment Agency. River floods – available at https://www.eea.europa.eu/data-and-maps/indicators/river-floods-2/assessment#tab-used-in-publications

[293] The European Environment Agency. Heavy precipitation in Europe – available at https://www.eea.europa.eu/data-and-maps/indicators/precipitation-extremes-in-europe-3/assessment

[294] Bevacqua, E. et al. 2019. Higher probability of compound flooding from precipitation and storm surge in Europe under anthropogenic climate change. *Sci. Adv.* 5, eaaw5531.

2.3. Flooding in national risk assessments

Flood risk in NRAs 2015

Flood risk in NRAs 2018/2019

Flooding remains the most common risk within the national risk assessments, with all Member States mentioning it. It is notable that the magnitude of impact and likelihood (on the 5 point scale when available) of floods is similarly assessed among Member States, suggesting that the risk of flooding is perceived similarly across Europe. There has been little to no change in assessed risk levels compared to the 2015 national risk assessments.

When assessing the risk of floods, many Member States refer to and make use of the data already gathered under the EU Floods Directive (e.g. flood-risk maps, areas of potentially significant flood risk). The EU Floods Directive requires Member States to assess the risk of three flooding event scenarios: floods with a low probability, or extreme event scenarios; floods with a medium probability (likely return period ≥ 100 years); and floods with a high probability.

Even though the majority of Member States have identified river flooding as the most frequent risk, some also included coastal and pluvial/flash flooding in their assessments. Many of those Member States included these other types of flooding for the first time as compared to the 2015 national risk assessments. This shows a recognition and an increased importance of the differing impacts and driving factors behind the different types of floods.

According to information provided in the national risk assessments, 15 Member States took into account the effects of climate change on flood risk. However, the assessment of cross-border impacts still appears to be significantly lacking. Only two Member States mentioned the cross-border dimension in their national assessment, despite more than half of the units of management[295] being identified in the EU as cross-border, in some cases with corresponding international flood risk management plans[296].

Some Member States discussed the cascading effects of floods. Most often these were disruptions to critical infrastructure: electricity networks/power outages, medical facilities, and telecommunication and transport networks. Sometimes, secondary hazards were also included such as marine pollution, industrial/chemical accidents, epidemics and pandemics, wildfires, erosion and landslides.

[295] Almost invariably, units of management correspond to river basin districts.

[296] International flood risk management plans were prepared for the following six transboundary river basins: Elbe, Danube, Meuse, Odra, Rhine and Scheldt.

2.4. Addressing the risk: EU actions

The assessment and management of flood risk in the EU is anchored in the EU Floods Directive (FD) of 2007[297]. In early 2019, the Commission published its assessment of how the FD and the Water Framework Directive (WFD) were being implemented, including the assessment of the first flood risk management plans (FRMPS) that had been developed by Member States[298]. The assessment concluded that the FD helped create a well-established flood risk management framework in the EU. All Member States took action and completed the first cycle of the Directive's implementation. It ended with FRMPs being prepared and adopted, which set out risk management measures for 2015-2021. There are already some examples of how flood prevention and protection measures that were carried out have been effective. For example, in Germany, improvements in the flood protection structures along the Elbe helped to reduce or completely avoid damage during the 2013 floods, while previous floods of similar magnitude in 2002 caused significant harm[299].

The 2019 implementation report that summarised the assessment of Member States' FRMPs also identified some areas for further improvement. The report found that although all Member States set objectives for managing flood risk and included measures, more detailed objectives and clearer explanations were needed on how measures would help achieve the objectives. Moreover, while most Member States identified possible funding sources, they often did not make any budgetary commitments for the planned measures in their FRMPs. Only half of Member States (14) made specific links between their FRMPs and national climate change adaptation strategies. In the report, the Commission recommended to Member States to further refine and complement their analysis and set out the necessary measures in the second round of FRMPs. It also recommended to better link the implementation of measures to the objectives so as to assess progress towards reducing flood risk. Lastly, specific funding sources should be identified to help implement measures. It is essential that flood risk management measures set out in FRMPs continue to be implemented, particularly in light of forecasted increases in flood risk due to climate change and growing exposure to floods.

The FD is currently in its second cycle of implementation. The first update of the flood hazard and risk maps was due in December 2019[300]. This will be followed by an update to Member States' FRMPs, due in December 2021.

In December 2019, the Commission published a multifaceted evaluation of a large part of the EU water law, including the FD. This evaluation also confirmed that the FD had led to better flood risk management in the EU, although it was too early to evaluate the full effect of the Directive, as not even the implementation of the first flood risk management plans had finished. It also found that measures to protect against flood risk had a positive cost-benefit ratio. By evaluating this set of laws on their effectiveness, efficiency, relevance, coherence and value added at the EU level thus far, the Commission was able to identify strengths and weaknesses which require follow-up action, of a legislative or non-legislative nature, in the coming years.

In terms of funding, the European Regional Development Fund and Cohesion Fund, provide significant resources for flood risk prevention and management in Member States and for cross-border and transnational cooperation in this area. As a result of investments allocated for 2014-2020, more than 16.5 million Europeans are expected to be better protected from floods[301]. Moreover, the EU Solidarity Fund provides financial aid for emergency and post-disaster reconstruction operations. In 2017-2019, the EU Solidarity Fund supported six Member States – Bulgaria, Latvia, Lithuania, Austria, Italy and Romania – allocating over EUR 330 million to deal with damages caused by floods in 2017 and 2018.

Looking forward, the Member States, the Commission and relevant stakeholders will continue coordinating actions to prevent and protect against floods under the common

[297] Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (Text with EEA relevance). *OJ L 288, 6.11.2007*

[298] Water Framework Directive and the Floods Directive Implementation Reports available at http://ec.europa.eu/environment/water/water-framework/impl_reports.htm

[299] Zurich Insurance Company. European floods: using lessons learned to reduce risks, 2013

[300] According to Article 6 of Directive 2007/60/EC on the assessment and management of flood risks.

[301] See https://cohesiondata.ec.europa.eu/themes/5#

implementation strategy. New focus areas have emerged for future work, such as flash flooding and the impacts of climate change on flooding at regional/sub-continental level.

Because of the uncertain evolution of climate change and scarce resources, the Commission recommends, where appropriate, a combination of grey[302] and green infrastructure[303] to protect against and prevent floods – an approach that should be considered at an early stage of planning. It is recommended that nature-based solutions be prioritised as these are often low- or no-regret solutions[304]. Examples include restoring floodplains and upland areas to decrease risk in downstream areas by retaining water, or green infrastructure in urban areas to reduce run-off during high-intensity precipitation events. A progress report on how the EU green infrastructure strategy has been implemented[305] found that, regarding EU water policy, natural water retention measures can help to slow down the flow of storm water, increase infiltration and reduce pollution through natural processes. Such measures are identified as cost-effective approaches to reach the objectives of the WFD and the FD, while they also help in protecting biodiversity and adapting to climate change. EU cohesion policy and agricultural funds encourage and provide financial support to the implementation of nature-based solutions.

In order to reduce economic damages from floods, it is important to reduce exposure and vulnerability by not building in flood-prone areas. Measures for spatial planning and land use were identified in the first FRMPs of 23 Member States. The most common approach is to introduce new spatial planning and land-use restrictions or bans on construction in flood-risk areas. In some cases, this involves binding rules.

It is also important to systematically raise flood risk awareness and preparedness amongst the population and improve coordination between flood risk management and civil protection authorities. Early warning systems of the European scale, such as EFAS, are vital for this purpose and help foster preparedness and coordination between authorities at national and river basin levels.

Lastly, Member States should assess whether encouraging economic instruments (including insurance) that incentivise flood risk reduction are relevant to their particular situation and existing mix of measures.

3. Drought

3.1. The risk and trends

Drought has been a recurrent feature of Europe's climate, not only limited to southern Europe or some EU outermost regions. Droughts have severe consequences for people and for most economic sectors, including agriculture, forestry, energy production, industry, river transport (waterways) and public water supply.

Compared to other natural disasters that unfold over a matter of hours, drought is a natural phenomenon characterised by a slow onset and can often last a long time. It can have a variety of possible impacts that can last for months or years after the event ends[306]. Droughts can be meteorological, agricultural, hydrological, or socioeconomic, occurring on different time scales and with different impacts. Meteorological droughts can begin and end relatively quickly and occur when dry weather dominates an area, leading to low soil moisture. They may be exacerbated by high temperatures (heatwaves). Hydrological droughts are more severe and long lasting and usually occur after many months of meteorological drought, taking place in areas with low groundwater levels and affecting watercourses, water resources, and natural ecosystems. Water scarcity can be affected by the rate of abstraction for agriculture and different socioeconomic needs.

[302] Grey infrastructure refers to the human-engineered infrastructure using hard building materials. In the case of flood protection, examples include barriers, dams, dikes and levees.

[303] Green infrastructure is defined as a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in both on-land (including coastal) and marine areas. Source: COM(2013) 249 final.

[304] No- or low-regret measures are relatively low cost measures that provide relatively large benefits under a range of future climate scenarios and that do not involve trade-offs with other policy objectives.

[305] COM(2019) 236 final.

[306] Spinoni J., Naumann G., Vogt J.V. (2017): Pan-European seasonal trends and recent changes of drought frequency and severity. Global and Planetary Change: 148, 113-130.

The severity and frequency of droughts have increased in Europe: in summer and autumn in southern and eastern Europe and in winter and spring in northern Europe[307] (*Figure 33*).

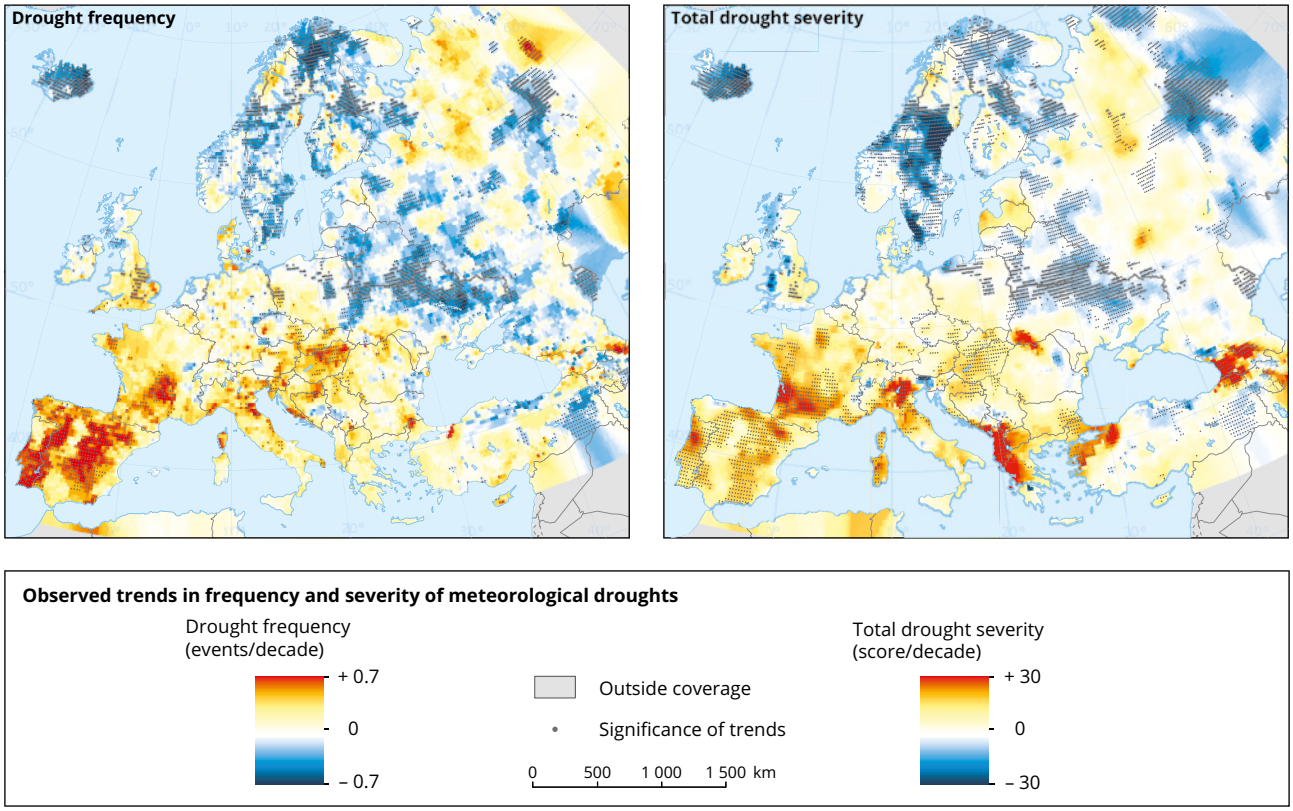


Figure 33. Trends in frequency and severity of meteorological droughts between 1950 and 2012. Source: EEA

A decrease in summer soil moisture content has also been observed in most of the Mediterranean region, particularly in south-eastern Europe, south-western Europe and southern France[308]. There has also been a decrease in summer low flows of European watercourses over the second half of the 20th century[309]. However, current data are insufficient to attribute the latter trend to global climate change.

From 2006 to 2010, 15% of EU territory has been affected by meteorological droughts each year[310]. Since 2011, Europe has experienced a severe drought almost every year, except for 2013 and 2016. Additionally, Europe's freshwater resources are under increasing stress, with a mismatch between the continuously increasing demand for, and the limited availability of, water resources across the EU. This has had significant impacts on many economic sectors. The PESETA IV study estimates current annual losses from drought to be around EUR 9 billion, with the highest losses in Spain (EUR 1.5 billion/year), Italy (EUR 1.4 billion/year) and France (EUR 1.2 billion/year). Depending on the region, between 39-60% of these losses relate to agriculture and 22-48% to the energy sector. Public water supply accounts for between 9% and 20%

[307] Idem.

[308] The European Environment Agency. Climate change adaptation and disaster risk reduction in Europe: Enhancing coherence of the knowledge base, policies and practices. EEA Report No. 15/2017 – available at https://www.eea.europa.eu/publications/climate-change-adaptation-and-disaster

[309] K. Stahl et al. Streamflow Trends in Europe: Evidence from a Dataset of near-Natural Catchments. – Hydrology and Earth System Sciences 14, no. 12 (1 December 2010): 2367–82.

[310] The European Environment Agency. Climate change adaptation and disaster risk reduction in Europe: Enhancing coherence of the knowledge base, policies and practices. EEA Report No. 15/2017 – available at https://www.eea.europa.eu/publications/climate-change-adaptation-and-disaster

of the total damage. Losses in the transport sector relate only to inland water transportation and on average represent 1.5% of total losses, while subsidence damage to infrastructure accounts for around 8% of total losses.

Drought also affects the environment in many different ways, yet these impacts are difficult to evaluate[311]. For example, forests at the lower altitudes of mountains in Europe are already suffering from decreased precipitation and increased temperatures, which is altering the suitability of locations for specific species. Drought and heatwaves can decrease the annual growth of the trees, which means less carbon sequestration, wood production, and less carbon storage in the long term. In a vicious circle, these changes are also making forest tree species highly susceptible to damage from biotic and abiotic sources – those caused by pest attacks, more frequent droughts, heatwaves, windstorms and forest fires[312]. For instance, between 2017 and 2019, over 270 million m^3 of drought-weakened standing timber in central Europe was destroyed by windstorms and spruce bark beetles. While the damage is spread across many countries, the greatest losses are seen in Germany, Czechia and Austria[313]. Large-scale drought has caused forest decay, meaning that large areas of forests will have to be regenerated with other drought/climate tolerant and site-adapted tree species, according to sustainable forest management principles.

As regards mitigating human impacts, civil protection authorities may need to intervene when droughts lead to water shortages or even crises. These may require, for example, the distribution of water for civil use through tankers or trucks or even restrictions on use and rationing. As droughts are often exacerbated by heatwaves, their secondary effects include wildfires, which are a particular concern for civil protection authorities in southern Europe (for more information on the risk of wildfires see section 4 of this Annex).

Box 16. Extreme droughts 2017–2019

- Drought affected most of central Italy in 2017, causing major agricultural losses, water restrictions in urban areas and increased forest fires. It was exacerbated by the heatwave in June and July 2017[314].
- In 2016-2017, France's outermost region Mayotte experienced a severe drought leading to disruptions in the supply of drinking water[315].
- Severe and prolonged summer drought was seen in central and northern Europe in 2018. An intense dry spell beginning in May 2018, combined with heatwaves, led to i) reduced agricultural production, ii) restricted supply of public water, iii) low transportation capacities on major rivers, iv) impacts on water quality and fish populations, and v) unprecedented wildfires in Scandinavia[316]. While the spring and summer of 2018 saw drought conditions in central and northern Europe, southern Europe experienced unusually wet conditions. This 'water seesaw' helped offset the negative impacts of the drought on agricultural yields, However such water seesaw conditions have been rare, and are becoming rarer[317].
- Several regions spanning from north-east to western Europe experienced drought in August 2019. This drought resulted from a combination of drivers, with different weight depending on location: the long-tail influence of the 2018 drought, the heatwaves of June/July 2019 and below-average precipitation in spring 2019[318].

311 Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

312 SWD(2013) 342 final.

313 Forest Economic Advisors. Central European Beetle and Windstorm Timber Disaster Report. Available at https://getfea.com/publication/central-european-beetle-windstorm-timber-disaster

314 Severe drought in Italy: July 2017. European Drought Observatory (EDO) analytical report. 27 July 2017 –available at https://edo.jrc.ec.europa.eu/documents/news/EDODroughtNews201707_Italy.pdf

315 CNEWS. Mayotte pourrait continuer à manquer d'eau jusqu'à la prochaine saison des pluies. 30 March 2017 – available at https://www.cnews.fr/france/2017-03-30/mayotte-pourrait-continuer-manquer-deau-jusqua-la-prochaine-saison-des-pluies

316 Drought in Central-Northern Europe: July 2018. European Drought Observatory (EDO) analytical report. 17 July 2018 – available at https://edo.jrc.ec.europa.eu/documents/news/EDODroughtNews201807_Central_North_Europe.pdf

317 Toreti et al. The exceptional 2018 European water seesaw calls for action on adaptation. Earth's Future, 7 (6): 652–663.

318 Drought in Europe: August 2019. European Drought Observatory (EDO) analytical report. 8 August 2019 – available at https://edo.jrc.ec.europa.eu/documents/news/EDODroughtNews201908_Europe.pdf

3.2. Key risk drivers

Over the 21st century, droughts are projected to increase in frequency, duration and severity across Europe, particularly in the Mediterranean, but also across large parts of western and central Europe (*Figure 34*). In recent years, northern Europe has also experienced water shortages.

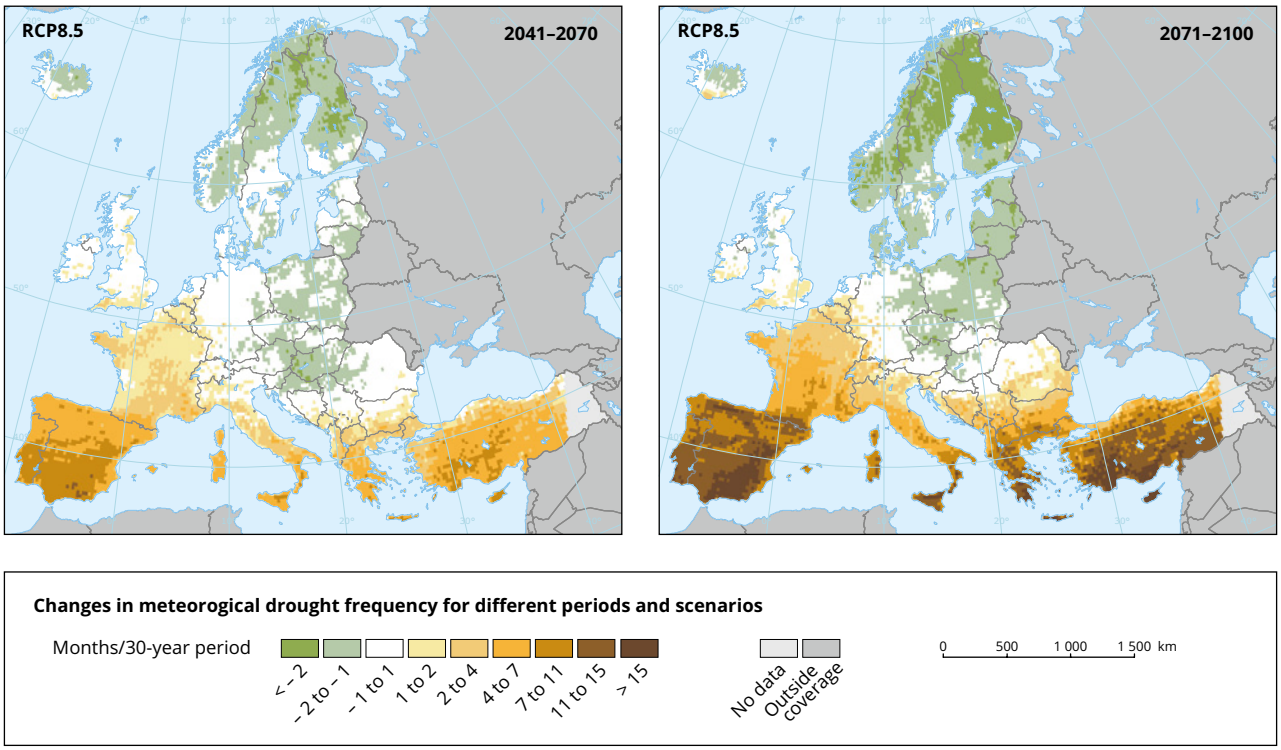
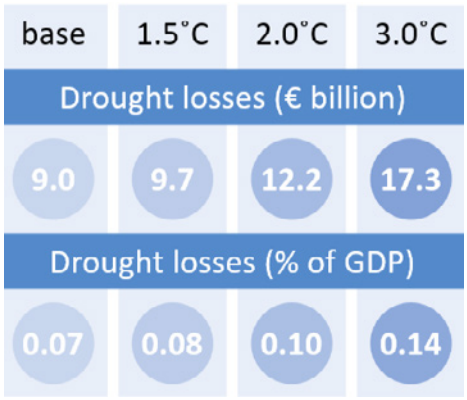


Figure 34. Projected change in the frequency of meteorological droughts

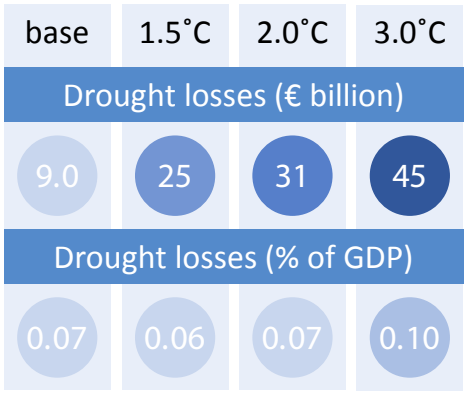
In combination with an increasing likelihood of severe heatwaves, droughts pose a significant threat for Europe. The extreme drought conditions that affected the 2018 spring and summer growing season in central and northern Europe, and led to unprecedented wildfires in Scandinavia, could become the norm within 25 years[319]. In southern Europe, the availability of water resources could drop by up to 40%. Water scarcity and drought would increasingly affect ecosystems, agriculture, energy production and water supply in regions that already suffer from water stress. In the absence of international market adjustments, crop yields would drop by more than 10% in southern Europe. Average annual drought losses are also expected to increase significantly (*Figure 35*). The Mediterranean and Atlantic regions will see the largest losses, with Belgium, Greece, Ireland, Portugal and the UK showing the highest increase in losses relative to now[320].

[319] Idem.

[320] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.



Average annual losses from drought for the EU and UK assuming that current socioeconomic conditions continue into the future



Average annual losses from drought for the EU and UK assuming socioeconomic conditions in 2100 according to the 2015 Ageing Report[321]

Figure 35. Average annual losses from drought for the EU and UK. Source: PESETA IV[322]

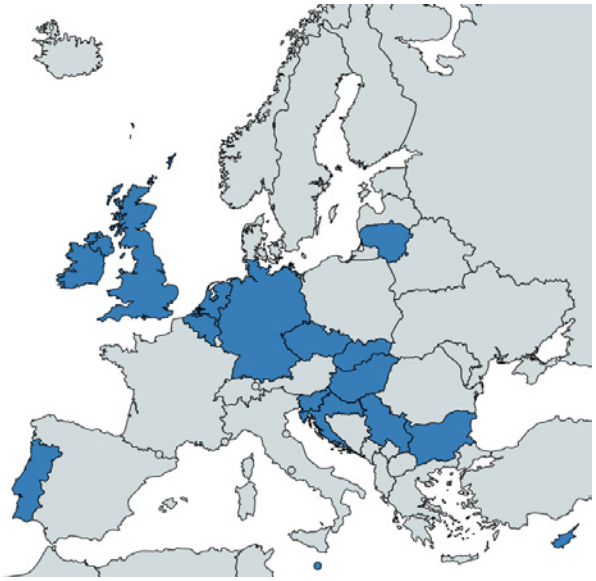
In addition to a changing climate (e.g. increased temperatures and precipitation deficits), human decisions can significantly affect the occurrence and impacts of droughts. While droughts are considered as natural phenomena, water scarcity is a direct result of human activities (where demand exceeds available resources) and has a direct effect on vulnerability and response to drought episodes. Over-abstraction of water resources, leading to water scarcity, soil compaction and soil erosion which result in the soil column having reduced water-holding capacities, and in the reduction of water-retaining surfaces, all contribute to an increasing likelihood of drought events, accompanied by their adverse impacts. Water stress already affects one third of EU territory all year round. This trend is expected to continue with water scarcity affecting most of Europe over the 21st century, with a 40-80% increase in the severity of water deficit events by 2050, except in northern European regions. In most regions around Europe, projected increases in water consumption will further aggravate river flow droughts[323].

[321] The economy of the future based on 2015 Ageing Report projections of population and economy. – The European Commission. The 2015 Ageing Report. Underlying Assumptions and Projection Methodologies. EUROPEAN ECONOMY 8/2014.

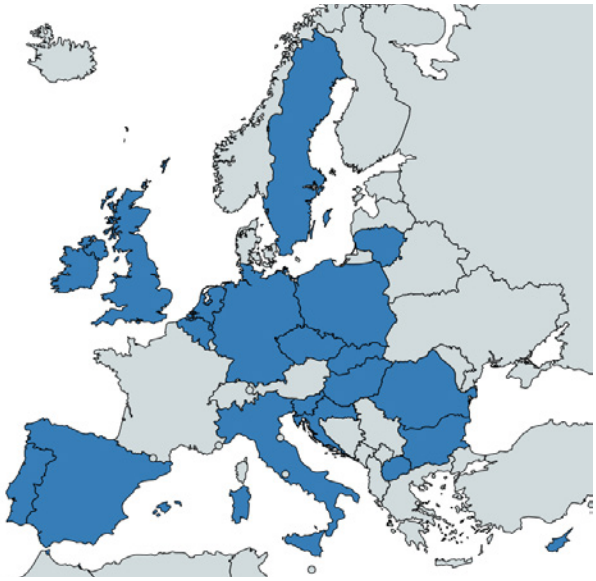
[322] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

[323] In a medium GHG emissions scenario (3.4°C warming by 2100), compared to a reference period 1961-1990. Source: G. Forzieri et al.: Ensemble projections of future streamflow droughts in Europe, *Hydrol. Earth Syst. Sci.*, 18, 85–108, 2014, quoted in 'Climate Change, impacts and vulnerability in Europe 2016', report by the European Environment Agency, 2017, P.147-148.

3.3. Droughts in national risk assessments



Drought risk in NRAs 2015



Drought risk in NRAs 2018/2019

Drought is a widespread risk across Europe, and is also taken into account in the national risk assessments. Sometimes it was included under forest fire risk and/or combined with heatwave risk or risk of water scarcity. However, more often than not drought was assessed as a stand-alone risk. Drought usually features on the upper end of the likelihood scale (on the 5-point scale when available) across those countries that included the risk of drought in their national risk assessments. Impacts were predominantly assessed to be in the middle range (2 or 3 on the 5-point scale when available). There has been little to no change in assessed risk levels compared to the 2015 of national risk assessments.

The cascading effects of droughts were discussed by some Member States. Most often these were impacts on critical infrastructure: disruptions to electricity networks/power outages, disruptions to road transport and provision of water, as well as impacts on the agricultural sector. Sometimes secondary hazards were also included, such as wildfires, air and water pollution, risks to food security, and food price volatility affecting the stability of the country's economic development. The effects of climate change on drought risk were taken into account by the majority of Member States that included the risk in their of national risk assessments.

Only one Member State mentioned the cross-border dimension of droughts, even though severe droughts are often a widespread, regional phenomenon. Additionally, the negative impacts of droughts on agricultural production not only have domestic consequences but can also have an impact on food supply in other countries.

3.4. Addressing the risk: EU actions

Multiple instruments exist in the EU for managing drought risk and water scarcity, including financial support. So far, the UCPM has never been activated to respond to droughts within Europe. On a few occasions, aid from the EU Solidarity Fund was granted to compensate for drought damage, but not since 2016[324]. The European Regional Development Fund and Cohesion Fund provide significant funds for investments in preventing and preparing for droughts in Member States, as well as for cross-border and transnational cooperation in this field.

The common agricultural policy, through the European Agricultural Fund for Rural Development (EAFRD), offers a wide range of possibilities for dealing with natural disasters affecting agriculture and forestry, such as drought. These include support for i) practices which step up resilience (e.g. improving water retention capacity in soils,

[324] See https://ec.europa.eu/regional_policy/en/funding/solidarity-fund/

establishing forest protection belts), ii) a shift towards more resistant and less water-intensive crops, or iii) investments in improved efficiency of irrigation equipment and infrastructure. In forestry, the EAFRD supports the introduction of drought tolerant species in new afforestation and reforestation, and increasing the resilience of existing forests. Support for training and advice is another important tool for addressing the consequences of drought and for helping in the adaptation to consequences of climate change.

The EAFRD also provides support to farmers through risk management instruments. These tools include crop, animal, and plant insurance, mutual funds, and an income stabilisation tool. Insurance and mutual funds compensate farmers for severe production losses, while the income stabilisation tool compensates farmers for income losses. Furthermore, when a natural disaster, such as drought, has been recognised by the responsible authority and has destroyed at least 30% of the agricultural production potential, Member States may provide support of up to 100% to restore the agricultural potential that was damaged. On restoring forests after natural disasters and fires, the threshold for the destruction level is 20% to be eligible for support.

The Water Framework Directive (WFD) requires Member States to monitor and address some quantitative aspects of water management, notably flows of surface water bodies as part of the good ecological status and the quantitative status of groundwater. The 2009 common implementation strategy guidance document No. 24 'River Basin Management in a Changing Climate', agreed by Member States' water directors, recommended that from the second planning cycle onwards climate-related threats and adaptation planning should be incorporated in the Member States river basin management plans (RBMPs). Almost all the items included in the definition of the Water Framework qualitative and quantitative status are sensitive to climate change and are well-suited for adaptation action thanks to the step-by-step cyclical approach.

The Commission's fifth implementation report of the WFD, which assessed the second set of RBMPs[325], found that some Member States had set objectives for drought management and included measures in their RBMPs for addressing potential impacts (i.e. developing drought management plans and linking their water management strategy with national strategies on climate change). However, there is still scope for improvement. Some 11 Member States considered drought not to be relevant. This geographically varied picture is not aligned with the occurrences of drought as they are identified by the European Drought Observatory (EDO)[326]. The report noted that there were still some issues that raised concern, such as exemptions from controls and permits for small abstractions, even when this leads to groundwater bodies not achieving good quantitative status. This is a problem given that in Europe 16% of the area of groundwater is affected by over-abstraction.

To help alleviate water scarcity, the Regulation on minimum requirements for water reuse was adopted in May 2020[327]. In the context of integrated water management, this Regulation aims to increase the uptake of water reuse by offering a sustainable, alternative water supply for agricultural irrigation.

The adoption of items within the river basin management plans that clearly address the key items for drought mitigation (indicators, measures, organisational set-up) can provide a stepwise approach, but their implementation has not been assessed in detail.

To complement the WFD, water scarcity and droughts were addressed in the Commission's 2012 Communication 'A Blueprint to safeguard Europe's water resources'[328], which included a 'Policy Review for water scarcity and droughts'. Also, the EDO has been put in place and is being strengthened. In collaboration with Member States, the EDO is monitoring current and past droughts at EU level and their impact on soils, vegetation and groundwater levels. Research is ongoing on drought forecasting aspects. Furthermore, the Commission closely cooperates with the European Environment Agency (EEA) to produce better

[325] COM(2019) 95 final.

[326] Available at http://edo.jrc.ec.europa.eu/

[327] Regulation (EU) 2020/741 of the European Parliament and of the Council of 25 May 2020 on minimum requirements for water reuse.

[328] Available at http://ec.europa.eu/environment/water/blueprint/index_en.htm

water scarcity and drought indicators, as well as quantitative statistics, and to improve the collection of information at EU level. The work on the Water Exploitation Index[329], or the promotion of water balances[330] are concrete examples of this cooperation. In addition, the Commission encourages all Member States to use natural water retention measures, as reflected in a policy document[331], a practical guide[332] and a platform containing a wealth of information and practical examples[333].

In December 2019, the Commission issued a multifaceted evaluation of a large part of the EU water laws, including the WFD[334]. This evaluation concluded that despite the recommendation for Member States to prepare drought management plans as part of their implementation of the WFD, not all Member States that had flagged droughts as a concern did so in the second cycle (2015-2021). Another key gap identified in the evaluation was insufficient attention given to water scarcity and drought management. In the context of water management, focus on water scarcity management is placed on water reuse and water efficiency measures.

A recent study, led by scientists in the European Commission's Joint Research Centre (JRC), calls for innovative adaptation measures to deal with drought extremes in the face of global warming[335]. Droughts, but also other climate extremes, in addition to human health and environmental impacts, pose particular challenges for agricultural production systems. Therefore, to reduce the impacts associated with these extreme events at local level, agricultural management and planning need to consider them when developing and implementing risk reduction strategies. European resilience analysis and disaster risk management for the coming decades needs to consider the projected reduced/lack of compensation provided by a water seesaw.

[329] Examples are available at http://www.eea.europa.eu/data-and-maps/figures/water-exploitation-index-plus-wei

[330] Additional information is available at http://ec.europa.eu/environment/water/blueprint/balances.htm

[331] Available at https://circabc.europa.eu/w/browse/bb786001-ed42-416d-836e-4835481ba508

[332] Available at http://nwrm.eu/implementing-nwrm/practical-guide

[333] See http://nwrm.eu

[334] SWD(2019) 439 final.

[335] Toreti et al. The exceptional 2018 European water seesaw calls for action on adaptation. Earth's Future, 7 (6): 652–663.

4. Wildfires[336]

4.1. The risk and trends

The EU is one of the most forested regions in the world, with a forest cover of nearly 160 million hectares, representing 36% of the EU's territory[337]. Approximately 38 million hectares of forest are included in the Natura 2000 network protecting EU's most valuable species and habitats. Forests provide society with a multitude of social, environmental, economic and cultural benefits. They also help mitigate climate change and protect biodiversity.

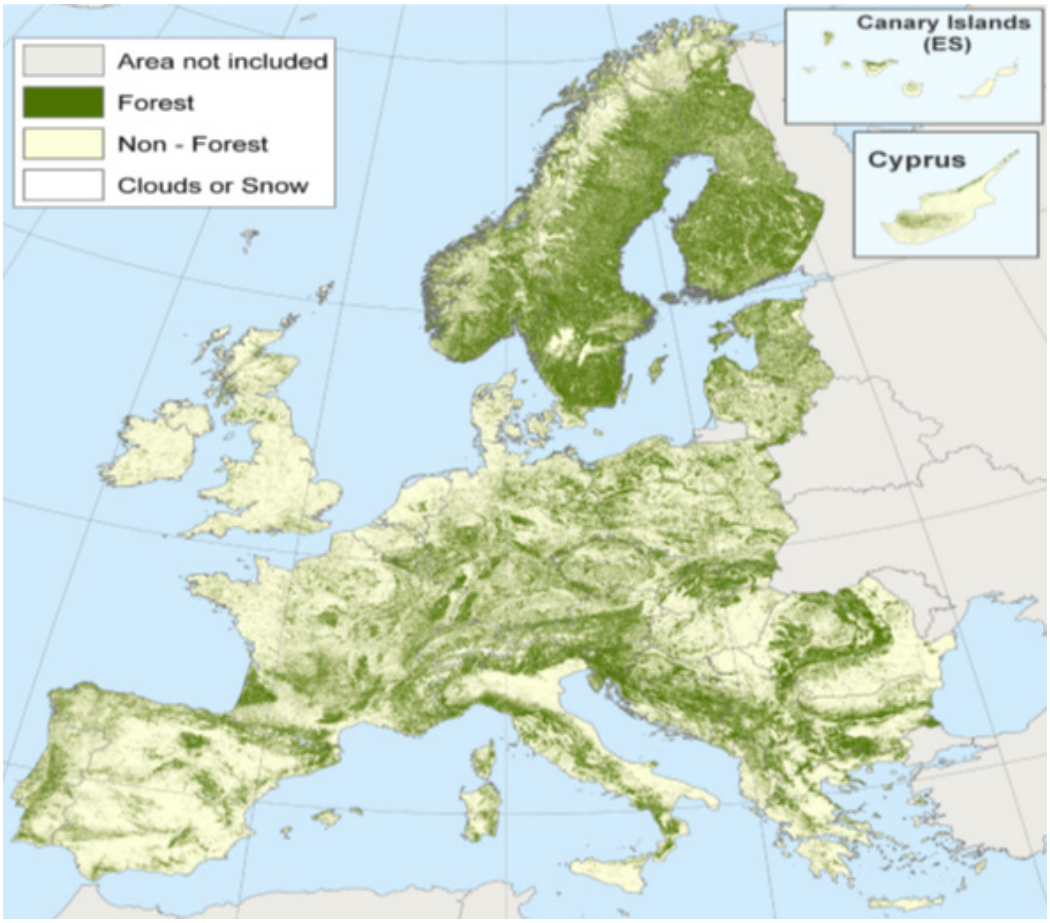


Figure 36. EU forest map. Source: JRC

One of the major hazards threatening European forests as well as other landscapes is fire, which causes significant social, economic and environmental damage. Over the past decade, fires in Europe have burnt more than 4 million hectares of forest and other wooded land – an area larger than Belgium. In the same period, more than 400 people (firefighters and civilians) lost their lives due to fire[338]. The environmental impacts of wildfires are difficult to estimate in monetary terms, but they can be devastating and sometimes irreversible, such as degradation or loss of natural ecosystems functions and services, and changes in biological diversity. There are also cascading effects since burnt areas become prone to post-fire flash floods, soil erosion, landslides and desertification.

[336] The term 'wildfires' includes forest fires and other fires out of control that may burn land cover types other than forests.

[337] Data as of 2018, for EU-28. Source: Forest Information System for Europe (FISE), available at https://forest.eea.europa.eu/topics/forest-basic-data

[338] Based on data provided by EU Member States/UCPM participating states to the annual reports on forest fires in Europe for 2008-2018. Available at https://effis.jrc.ec.europa.eu/reports-and-publications/annual-fire-reports/

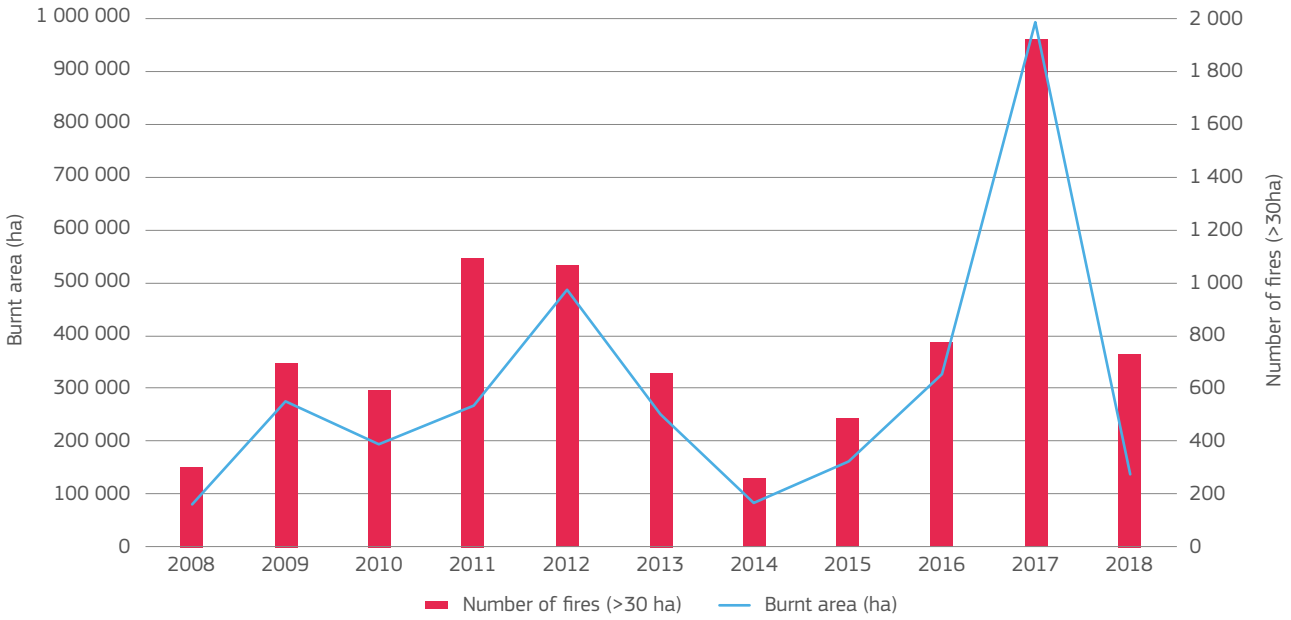


Figure 37. Number of wildfires and the size of area burnt in the EU, 2008-2018 (data from the European Forest Fire Information System (EFFIS) on fires of 30 ha or larger)

The number of wildfires occurring and the size of the area burnt vary from year to year (*Figure 37*). 2017 and 2018 were particularly dramatic in terms of fire activity (number, magnitude and severity) and human casualties *(Box 17)*. In those 2 years, wildfires killed more than 200 people. More than a million hectares of territory was burnt, a quarter of which was in protected areas under Natura 2000. The economic damage caused by fires was estimated at around EUR 10 billion in 2017[339] and EUR 2.5 billion in 2018[340]. The 2019 wildfire season was also unusual. The year started with a large number of winter (off-season) fires, which in a few months destroyed more forests than during the whole of 2018 *(Figure 38, Figure 39)*.

Box 17. The extremes of forest fires in 2017-2019

- In 2017, Portugal experienced an extremely devastating fire season. A total of 112 people lost their lives. Almost 6% of the country's surface was burnt, exceeding the yearly average by five times[341].
- The 2018 Attica forest fires in Greece killed 102 people and burnt 1 276 ha. These have been the second deadliest wildfires of the 21st century so far, after the 2009 Black Saturday bushfires in Australia that killed 180 people[342].
- In 2018, Sweden fought unprecedented fires that burnt an area 10 times larger than the yearly average. Other parts of Scandinavia, the UK, Ireland, Latvia and Germany also witnessed higher than usual fire activity [343].
- In 2019, both the number of fires and the area burnt exceeded the averages of the past decade (*Figure 38, Figure 39)*.

[339] Forest Fires in Europe, Middle East and North Africa 2017. JRC Technical Report, 2018. Available at https://effis.jrc.ec.europa.eu/reports-and-publications/annual-fire-reports/

[340] Forest Fires in Europe, Middle East and North Africa 2018. JRC Technical Report, 2019. Available at https://effis.jrc.ec.europa.eu/reports-and-publications/annual-fire-reports/

[341] The European Commission. Annual report on Forest Fires in Europe, Middle East and North Africa 2017. Available at https://effis.jrc.ec.europa.eu/reports-and-publications/annual-fire-reports/

[342] National risk assessment for Greece, 2019.

[343] The European Commission. Annual report on Forest Fires in Europe, Middle East and North Africa 2018. Available at https://effis.jrc.ec.europa.eu/reports-and-publications/annual-fire-reports/

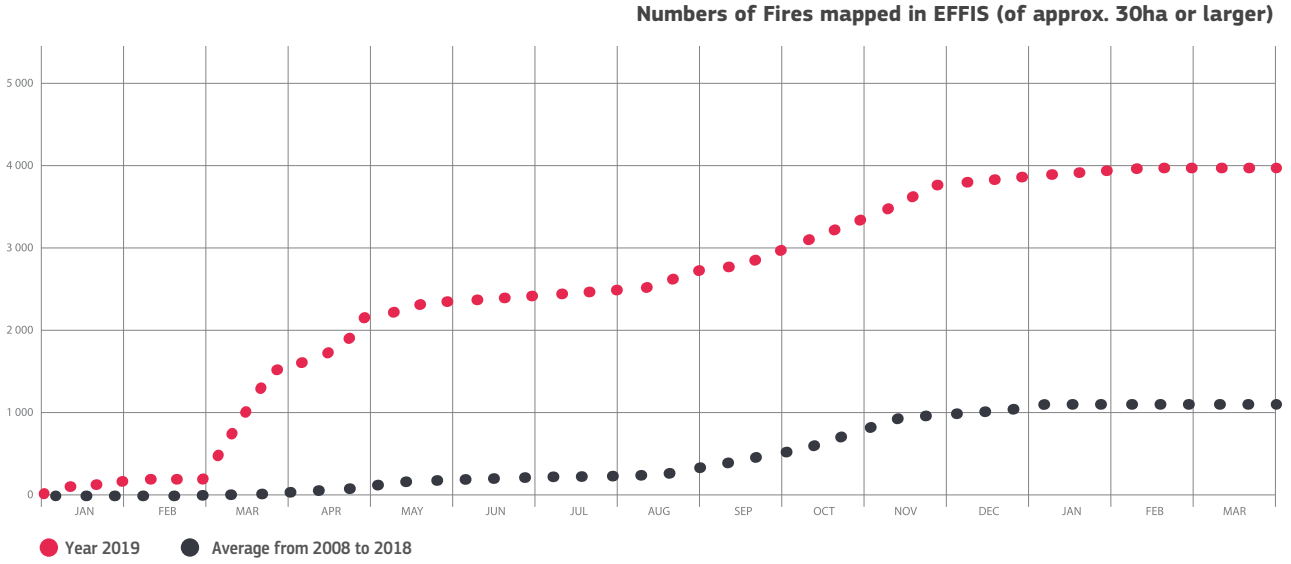


Figure 38. Trends in the number of wildfires in Europe: 2019 compared to 2008-2018 average (EFFIS)

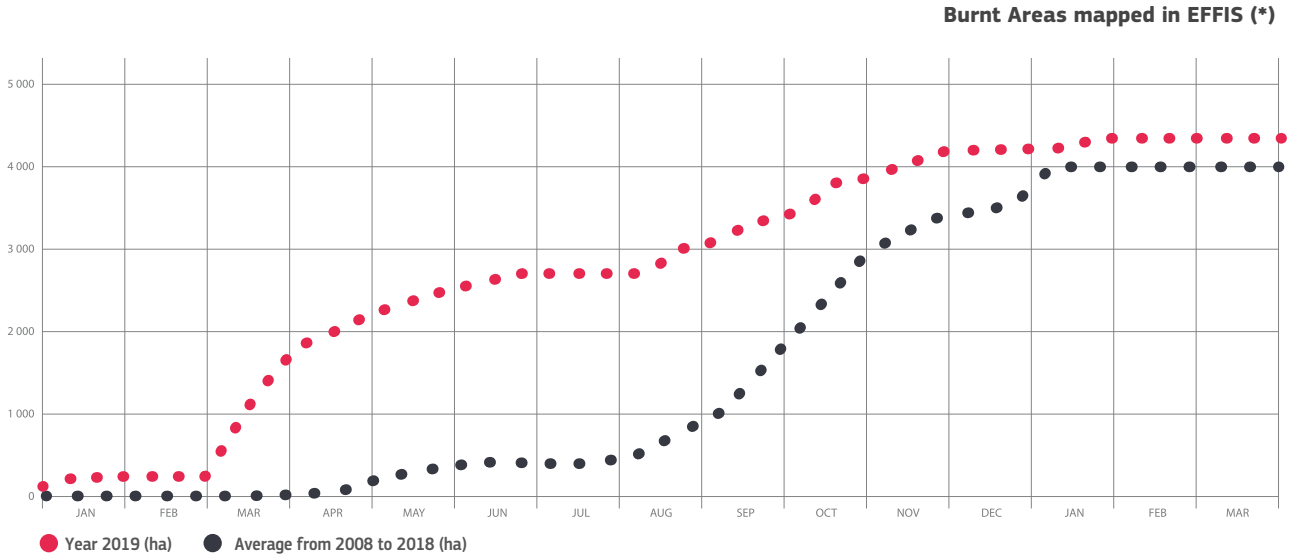


Figure 39. Trends in the burnt area in Europe: 2019 compared to 2008-2018 average (EFFIS[344])

While the Mediterranean region is the most affected by wildfires, the risk is a cause of concern also in other parts of the EU. Recent years have shown that extreme wildfire events are happening in new locations, such as northern Europe and even the Arctic. *Figure 40* shows the levels of fire danger in Europe on 23 July 2018, when many fires were raging across Europe.

[344] The burnt areas mapped in EFFIS represent, on average, about 80% of the total area burned by wildfires, since only fires larger than 30 ha are mapped. The area burnt by fires smaller than 30 ha represent about 20% of the total burnt area in each country, but this area is not mapped in EFFIS.

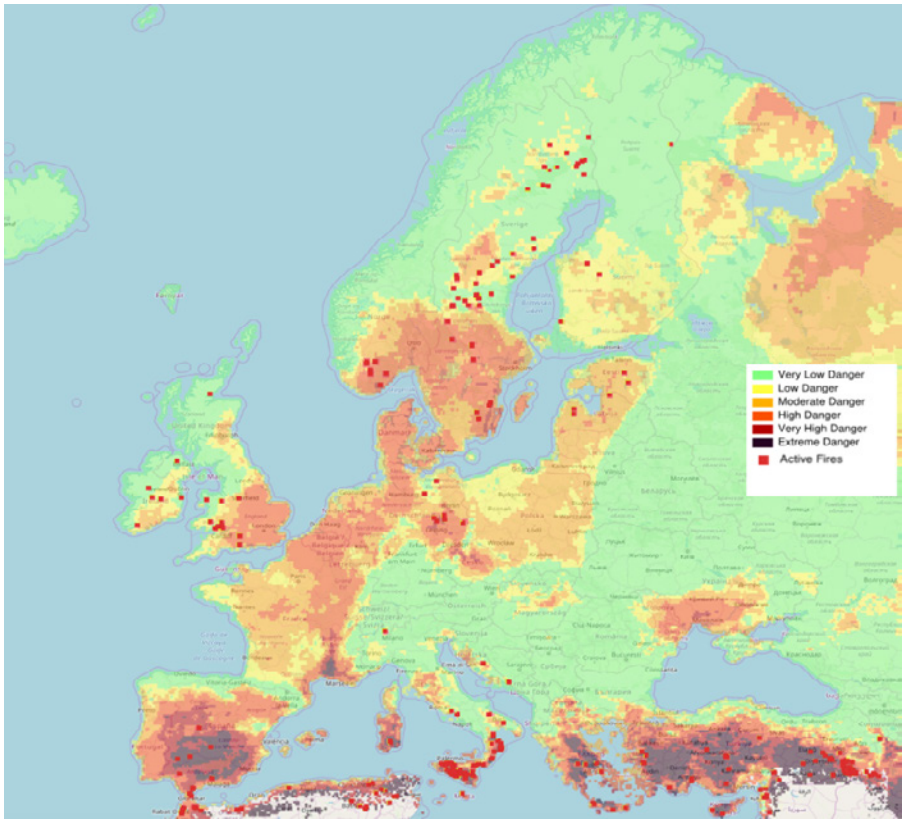


Figure 40. Fire danger in Europe on 23 July 2018

Another trend observed in recent years is that wildfire seasons are starting earlier than usual and lasting longer. Moreover, the frequency and severity of fires have increased, triggering reflections on how to deal with the phenomenon of 'megafires'[345].

4.2. Key risk drivers

Wildfires can be caused either by natural phenomena (e.g. heatwaves, increased temperature, and lightning) or human activity. The likelihood of a fire igniting and spreading depends on the type of vegetation, fuel on the ground, topography and weather conditions. The impact depends on the i) amount of fuel that is available to burn, ii) weather conditions that determine the fire spread, iii) fire intensity, iv) assets that may be subject to damage (i.e. the proximity of population or infrastructure) and v) capacity to suppress the fire.

In Europe, approximately 95% of wildfires are directly or indirectly caused by human behaviour and activities, including negligence and arson[346]. Socioeconomic developments and changes in land use have helped create structural conditions conducive to human-induced wildfires. The movement of people from rural to urban areas, the abandoning of traditional land uses and unsustainable forest management practices (e.g. lack of proper management and vegetation control) have resulted in a large accumulation of combustible fuels and made forests more prone to fires. At the same time, urban sprawl and the growing urban-wildland interface have led to more frequent and dangerous disasters, sometimes with human casualties[347].

[345] The European Commission. Forest Fires. Sparking firesmart policies in the EU. – Luxembourg: Publications Office of the European Union, 2018. ISBN 978-92-79-77493-5 doi:10.2777/181450 KI-AZ-18-006-EN-N.

[346] Ganteaume, A., Camia, A., Jappiot, M., San-Miguel-Ayanz, J., Long-Fournel, M., Lampin, C., 2013. A review of the main driving factors of forest fire ignition over Europe. Environmental Management 51 (3), 651-662. https://doi.org/10.1007/s00267-012-9961-z

[347] The European Commission. Forest Fires. Sparking firesmart policies in the EU. Luxembourg: Publications Office of the European Union, 2018. ISBN 978-92-79-77493-5 doi:10.2777/181450 KI-AZ-18-006-EN-N.

Along wildland-urban or wildland-industrial interfaces, wildfires can affect hazardous infrastructure or industrial zones, leading to major accidents with toxic releases, fires or explosions (known as Natech accidents). Fires can affect industrial facilities via thermal radiation (heat), ember flight or direct flame impingement affecting vulnerable industrial equipment. The transformation of the areas surrounding industrial facilities as well as climate change raise concerns about future industrial plant safety in wildfire risk zones. To date there is no integrated European fire management system that would meet the requirements to prevent Natech accidents triggered by wildfires[348].

Overall, the weaknesses in forest and fire risk management practices have played a role in and indirectly contributed to the creation of fire risks. A recent overview of the research on the topic concludes that there is insufficient and fragmented attention being paid to preventing wildfires in Europe, with the main focus and resources placed on suppression. Policies on spatial planning, national forestry strategies and others have not sufficiently integrated considerations on fire prevention. Preferred firefighting strategies (e.g. early initial attack) have contributed to fuel accumulation and landscapes being more prone to large and intense fires. Action to raise risk awareness and people's preparedness also needs to be stepped up[349].

In future, wildfire risk is projected to increase due to climate change. Warmer temperatures and longer periods without rain will help fires to ignite and spread, leading to more frequent and intense fires. The PESETA IV study estimates that the probability of high-to-extreme danger of wildfires will rise nearly everywhere in Europe (*Figure 41*). Only in scattered parts of northern Europe (the area around and south of the Baltic Sea) are the number of high-to-extreme fire danger days projected to decrease slightly. Fire danger will worsen especially in southern regions of Europe, where fires already occur more often and are more intense[350].

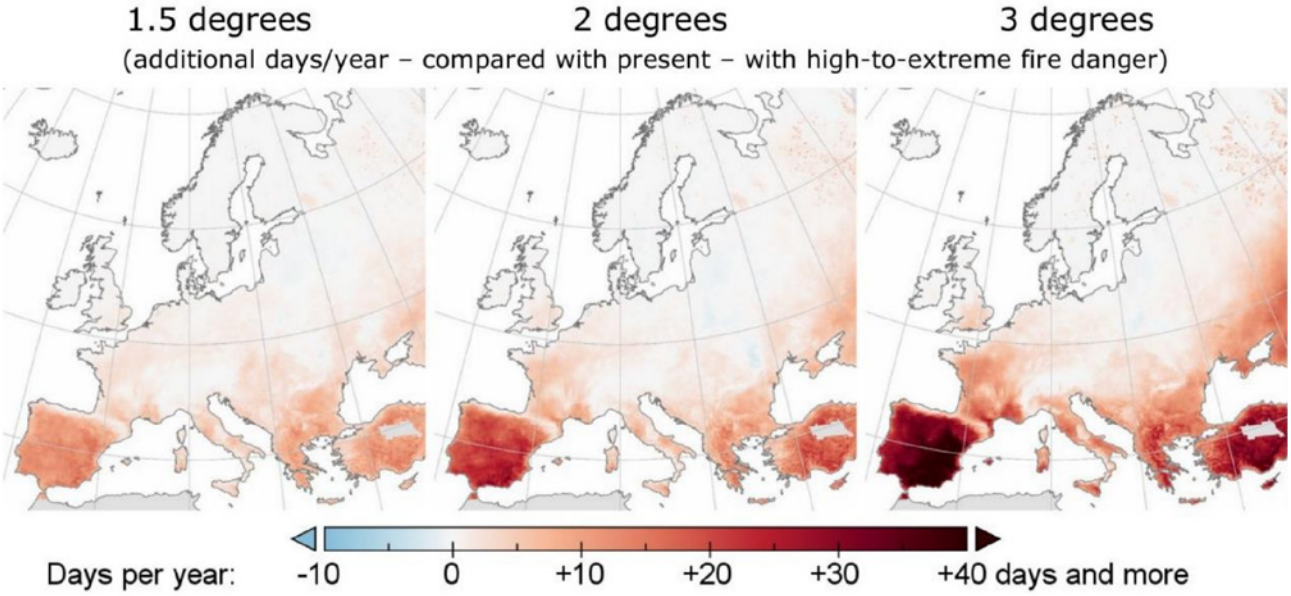


Figure 41. Additional number of days per year with high-to-extreme fire danger (daily Fire Weather Index ≥ 30) for different levels of global warming compared to present (1981-2010). Source: PESETA IV[351]

[348] Kern, H., Krausmann, E. (2020) Wildfires triggering Natech events – a structural analysis of Natech hazards in the context of the emerging wildfire threat in Europe, EUR 30293 EN, European Union, 2020.

[349] The European Commission. Forest Fires. Sparking firesmart policies in the EU. Luxembourg: Publications Office of the European Union, 2018. – ISBN 978-92-79-77493-5 doi:10.2777/181450 KI-AZ-18-006-EN-N.

[350] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

[351] Idem.

Climate change will also affect wildfire risk through changes in forest growth and productivity, tree species composition, and ecosystems' evolution and health. Already over the last two decades, the combination of rising temperature and changes in precipitation has reduced plant defence mechanisms and increased their vulnerability to insect outbreaks, particularly in high-latitude regions. In the future, southern Europe and the Boreal areas are expected to experience significant changes in the prevailing components of ecological domains. The transformation of bioclimatic conditions is likely to outpace the time required for vegetation to adapt, making the latter more vulnerable to fires and affecting recovery afterwards[352].

In a vicious circle, forest fires themselves contribute to climate change, both due to greenhouse gas emissions from burning forests (*Figure 42*) and as a result of forest degradation.

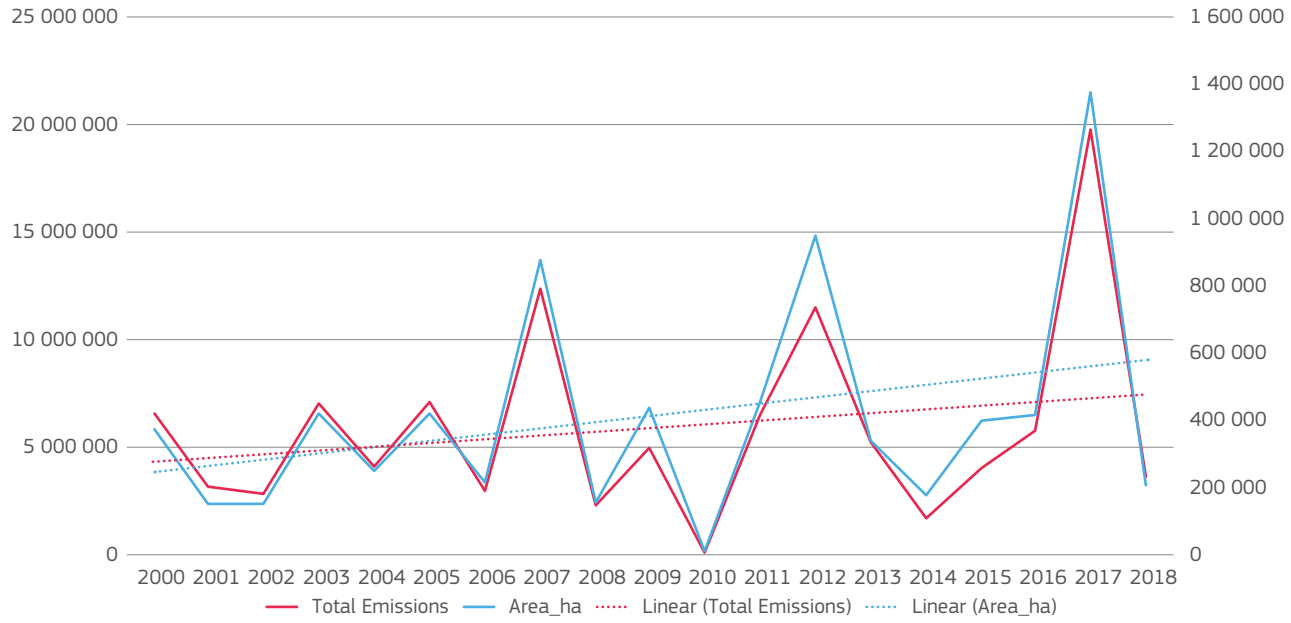


Figure 42. Total wildfire emissions in the EU (tonnes)

[352] Idem.

4.3. Wildfires in national risk assessments

Wildfire risk in NRAs 2015

Wildfire risk in NRAs 2018/2019

National risk assessments reflect the fact that wildfires are a widespread problem throughout Europe. Twenty-five countries from different regions of the continent include wildfires among their national disaster risks. The terminology used slightly differs, depending on national definitions and local characteristics of the fire landscape: the reports refer to the risk of 'forest fires', 'wildfires', 'vegetation fires', 'rural fires', 'landscape fires', 'forest and peat fires', etc.

The estimated level of wildfire risk varies considerably across Europe, depending on the type of vegetation, climatic conditions, topography, and socioeconomic and other factors. In the Mediterranean countries, wildfires are considered as a major risk, with a high likelihood and high impact, affecting human life and health, property, public infrastructure, cultural and natural heritage and employment. Although fire is an integral part of Mediterranean forest ecosystems, the urban sprawl into forested areas has led to a significant number of human casualties and significant damage over recent years. In other parts of Europe, while wildfires are frequent events, their magnitude and consequences are comparatively less severe.

The level of risk varies not only among, but also within the countries. Mapping fire risk zones at national and regional level is an established practice in European countries, taking into account the different types of vegetation, fuels, local weather conditions and other local characteristics affecting the fire risk probability. Wildfire risk maps are a useful tool for the responsible authorities as they can support the development of fire management plans, help prioritise interventions and allocate resources for firefighting or feed into decisions on land management.

Statistics included in the national reports confirm that the majority of fires are triggered by humans. However, there is a variation from country to country in the proportion of deliberate as well as unidentified causes of incidents. The areas with the heightened risk of fires are those where natural landscapes 'meet' human settlements and activities. The wildland-urban interface receives particular attention in a number of national risk assessments, especially those from the Mediterranean region.

National assessments of wildfire risk are based on the analysis of a variety of scenarios. These include: i) fires in the wildland-urban interface, protected areas under Natura 2000 or in the vicinity of critical infrastructure, ii) situations with several contemporaneous fires, iii) fires under extreme weather conditions or iv) fires spreading from the neighbouring country.

National reports describe a wide range of adverse consequences caused by forest fires:

- they endanger human lives and health;
- they destroy property, critical infrastructure, and cultural heritage;
- they result in the loss of timber, biodiversity and have severe impacts on the economy, environment and tourism; and
- they result in increased greenhouse gas emissions and air pollution affecting human health.

The negative effects might be felt long after the fire has been extinguished:

- damaged and degraded forests become more prone to pests and plant diseases;
- invasive species may be introduced; and
- floods, soil erosion and landslides may occur.

All this further reduces the resilience of natural ecosystems to fires. A few countries also note the increasing costs of firefighting, which put an additional strain on public budgets.

The majority of national reports acknowledge the role that climate change plays in exacerbating the risk of wildfires in terms of how it increases the probability of fires starting, the rate of spread, the intensity and the magnitude. Looking ahead, the assessments anticipate that the risk of wildfires will increase almost everywhere in Europe, both in terms of likelihood and negative impacts. The number of days with a high level of fire danger is expected to increase. The vulnerability of forests to fire hazard will grow, for instance, due to drier conditions, soil erosion and degradation and proliferation of pests. Conflagrations will be more frequent. Fires will occur in areas that historically have not been prone to them. All these developments will pose new challenges for risk prevention, suppression and recovery. A number of reports highlight the need to boost action to prevent and prepare for fires through sustainable forest management practices and a more holistic approach to risk management.

4.4. Addressing the risk: EU actions

In order to prevent wildfires, sustainable forest management and adaptation to changing climate are key. The EU's 2013 forest strategy[353] has been the main framework guiding the EU and Member States actions in this area. The EU is currently developing a new EU forest strategy due in 2021.

Monitoring and assessment of the wildfire risk at European level is supported by the European Forest Fire Information System (EFFIS)[354]. EFFIS is continuously being upgraded to provide the most up-to-date and reliable data on forest fires. One of the recent components added to EFFIS is the decision support system – a functionality containing data on the relative severity and potential threat of each forest fire. Such information should help assess emergency situations and help prioritise response actions. Another recent European Commission initiative is the development of a harmonised assessment of wildfire risk at pan-European level. This assessment provides a comparable and comprehensive picture of the risk in Europe and can support international collaboration on risk management[355].

The EU helps to better prepare for wildfires through regular exercises involving several Member States. When a fire gets too large for a country to fight on its own, it can ask for assistance through the UCPM. In general, wildfires are the main emergency events within the EU that trigger requests for international assistance (see also section 3.1.2. of the main report). During 2017-2018, support in fighting wildfires was requested 15 times by six Member States[356], from both southern and northern Europe. The assistance provided to Sweden in fighting wildfires during the summer of 2018 was the largest European civil protection operation to battle wildfires in the last decade.

The extreme wildfire season of 2017 revealed the UCPM's limits in responding to multiple emergency situations, in

[353] COM(2013) 659

[354] Available at http://effis.jrc.ec.europa.eu/

[355] San-Miguel-Ayanz, J., Costa, H., de Rigo, D., Libertà, G., Artés Vivancos, T., Durrant, T., Nuijten, D., Löffler, P., Moore, P. et al. 2018, Basic criteria to assess wildfire risk at the Pan-European level. EUR 29500 EN, ISBN 978-92-79-98200-2, doi:10.2760/052345.

[356] France, Greece, Italy, Latvia, Portugal, Sweden.

particular when they were taking place simultaneously. This was one of the key reasons that prompted the UCPM's legislation to be revised[357]. This resulted in the European Civil Protection Pool being strengthened and a new reserve of European response capacity – the 'rescEU' reserve – being introduced, which will serve as a safety net. Aerial firefighting means were identified as the first priority to be addressed when developing the rescEU pool.

In terms of long-term prevention, national and regional rural development programmes funded under the common agricultural policy provide significant resources for investment in forestry measures, including those for addressing the fire risk. The cohesion policy also provides significant funds for wildfire prevention and risk management in Member States as well as for cross-border and transnational cooperation in this area. Thanks to all the investments allocated for 2014-2020, more than 16.5 million Europeans are expected to be better protected from wildfires[358]. Moreover, the EU Solidarity Fund provides financial aid for emergency and post-disaster reconstruction operations. In 2017-2019, the EU Solidarity Fund supported two Member States, Portugal and Spain, allocating EUR 54 million to deal with damages caused by wildfires in 2017.

Wildfire risk also receives attention in the EU macro-regional strategies. For example, recently the white paper for policy makers 'Forest fires in the Alps: State of knowledge, future challenges and options for an integrated fire management' has been developed as part of the activities under the EU strategy for the Alpine Region[359].

The EU has been funding research into wildfires over the last two decades through its framework programmes and other funding instruments. Some 60 research projects received a total EU contribution of more than EUR 100 million[360]. These projects varied from large-scale integrated projects to smaller projects and individual Marie Skłodowska-Curie grants. The LIFE programme and the UCPM funded demonstration projects on effective wildfire management. EU-funded research has accelerated advances in fire knowledge, operational management and decision support mechanisms while stepping up cooperation among key organisations.

To harness available knowledge of wildfire risk and put forward evidence-based policy recommendations for more effective risk management, the Commission took the initiative to review the EU-funded research on wildfires. The review[361] concludes that the changing context of wildfires in Europe requires a shift towards a more holistic fire management approach – one which addresses the climatic, environmental and socioeconomic reasons for why fires start. Stronger and longer-term action in prevention and investment are crucial. The basis for action should be sustainable forest management strategies. Risk awareness and preparedness of local populations need to be strengthened. The suppression capacity will need to be built up to fight more extreme fires, during a longer season. Further knowledge is needed on the impact of climate change on wildfires within and beyond fire prone areas so as to be better ready for the future[362].

Recent research also highlights the importance of land-use planning along wildland-urban and wildland-industrial interfaces in order to protect critical infrastructure and industry assets from the impacts of wildfire in a changing climate[363]. It recommends developing guidance and strategies for tackling wildfires in an around industrial facilities, considering their specific vulnerability and potential to trigger cascading effects when damaged.

Overall, it is important that fire risk management is based on science and the newest availale technology. In order to facilitate the advancement and uptake of research results, the Horizon 2020 Green Deal call launched in September 2020 included a topic dedicated to the prevention and fight

[357] Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism, amended by Decision (EU) 2019/420.

[358] See https://cohesiondata.ec.europa.eu/themes/5#

[359] Forest fires in the Alps: State of knowledge, future challenges and options for an integrated fire management. White paper for policy makers. February, 2020. Available at https://www.alpine-region.eu/results/forest-fires-alps-state-knowledge-and-further-challenges

[360] The European Commission. Forest Fires. Sparking firesmart policies in the EU. – Luxembourg: Publications Office of the European Union, 2018. – ISBN 978-92-79-77493-5 doi:10.2777/181450 KI-AZ-18-006-EN-N.

[361] Idem.

[362] Forest Fires in Europe, Middle East and North Africa 2017. JRC Technical Report, 2018. Available at https://effis.jrc.ec.europa.eu/reports-and-publications/annual-fire-reports/

[363] Kern, H., Krausmann, E. (2020) Wildfires triggering Natech events – A structural analysis of Natech hazards in the context of the emerging wildfire threat in Europe, EUR 30293 EN, European Union, 2020.

of extreme wildfires with the integration and demonstration of innovative means. EUR 75 million have been allocated for these activities[364].

5. Geophysical risk[365]

5.1. The risk and trends

The Earth is a constantly evolving system. The movements of the tectonic plates cause strain and energy to accumulate deep underground. When an earthquake occurs, the freed energy travels through the earth in the form of waves that, having reached the surface, manifest themselves as rapid movements of land that strike people, buildings and the surroundings. Strong earthquakes with an epicentre in the sea or near the coast may cause a tsunami – a sudden displacement of a large mass of water that in extreme cases can reach over 30 metres in height. Tsunamis may also be caused by coastal or submarine landslides, volcanic activity in the sea or near the coast and, more rarely, by meteorites falling into the sea.

The collision of the Eurasian and the African plates is responsible for earthquakes in the southern part of Europe and the Eastern Mediterranean region (*Figure 43*), in countries such as Portugal, Spain, France, Italy, Croatia, Slovenia, Serbia, Montenegro, Albania, Bulgaria, North Macedonia, Greece, Cyprus and Turkey. Consequently, the Mediterranean coasts are also exposed to tsunami risk that is intensified by the presence of multiple volcanoes in the area. Movements of smaller plates also occur within Europe, for example in the Vrancea region in Romania. As major active seismic zones in Europe cross country boundaries, an earthquake may affect more than one country.

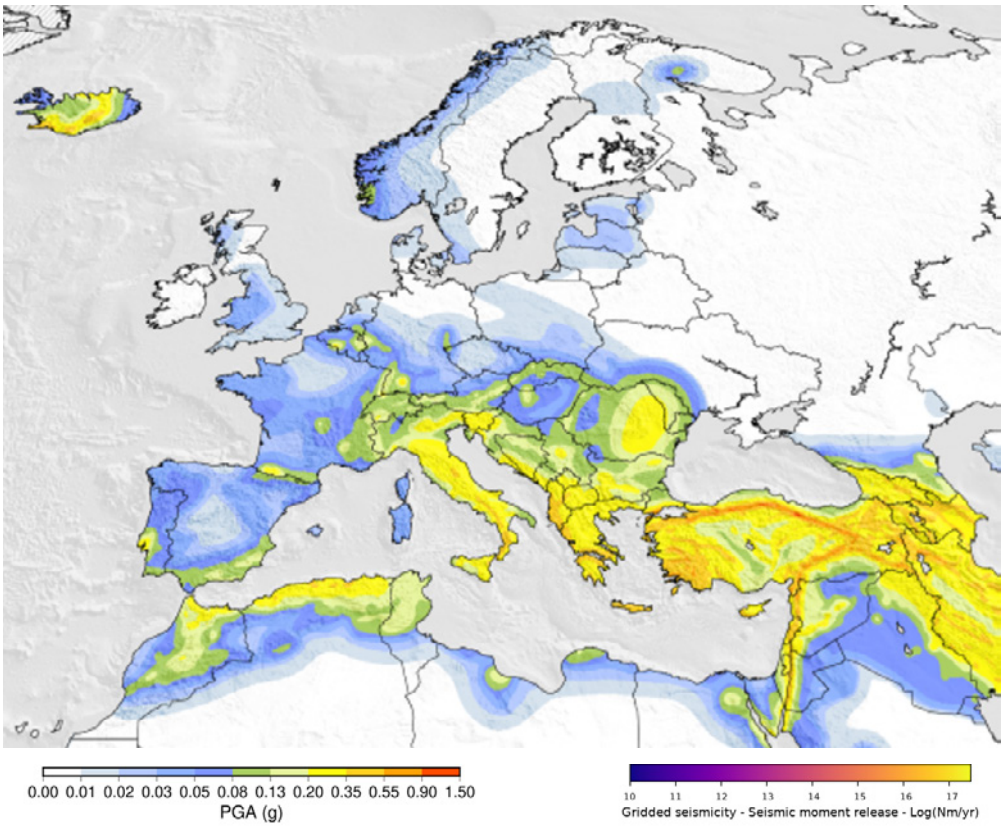


Figure 43. Seismic hazard map. Source: Global Earthquake Model (GEM)[366]

[364] Horizon 2020 Framework Programme. Preventing and fighting extreme wildfires with the integration and demonstration of innovative means. – Available at https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/lc-gd-1-1-2020

[365] For the purposes of this document, geophysical risks encompass natural hazards caused by geological conditions, notably earthquakes, volcanic eruptions and tsunamis. Other geological risks (such as landslides, ground instability, cavity collapse, erosion) are not covered in this section.

[366] Pagani M., J. Garcia-Pelaez, R. Gee, K. Johnson, V. Poggi, R. Styron, G. Weatherill, M. Simionato, D. Viganò, L. Danciu, D. Monelli (2018). Global Earthquake Model (GEM) Seismic Hazard Map (version 2018.1 - December 2018), DOI: 10.13117/GEM-GLOBAL-SEISMIC-HAZARD-MAP-2018.1.

The impacts of earthquakes can vary from localised effects to dramatic consequences on a wider scale for communities, infrastructure, the economy and the environment. Similarly, volcanic eruptions may have a limited impact or lead to disastrous events with consequences felt not only in the surrounding area, but potentially at a regional or even global level.

Seismic risk is determined by the combination of seismic hazard, exposure of people and physical assets, and vulnerability of the built environment. Ground shaking caused by small earthquakes frighten people and may cause minor property damage, but moderate to severe ground motion could cause moderate to heavy damage in structures, including their partial or complete collapse. The collapse of buildings is one of the main causes of death during an earthquake. To reduce fatalities, buildings and infrastructure must be designed, constructed or retrofitted according to modern anti-seismic provisions, such as the Eurocodes[367].

Earthquakes can trigger secondary effects, such as landslides, damage to vital infrastructure, liquefaction of the soil, tsunamis, debris avalanche and fires that sometimes cause more damage than the tremor itself. They can also lead to damage to vital infrastructure and Natech events, such as the release of hazardous materials from damaged industrial facilities.

Based on the NatCatSERVICE database, geophysical disasters (earthquakes, tsunamis, volcanic eruptions) that took place between 1980 and 2017 killed more than 3 600 people and caused EUR 86 billion in losses *(Figure 44).* The sequence of quakes that struck central Italy in 2016-2017 was one of the most disastrous events seen in Europe in recent years.

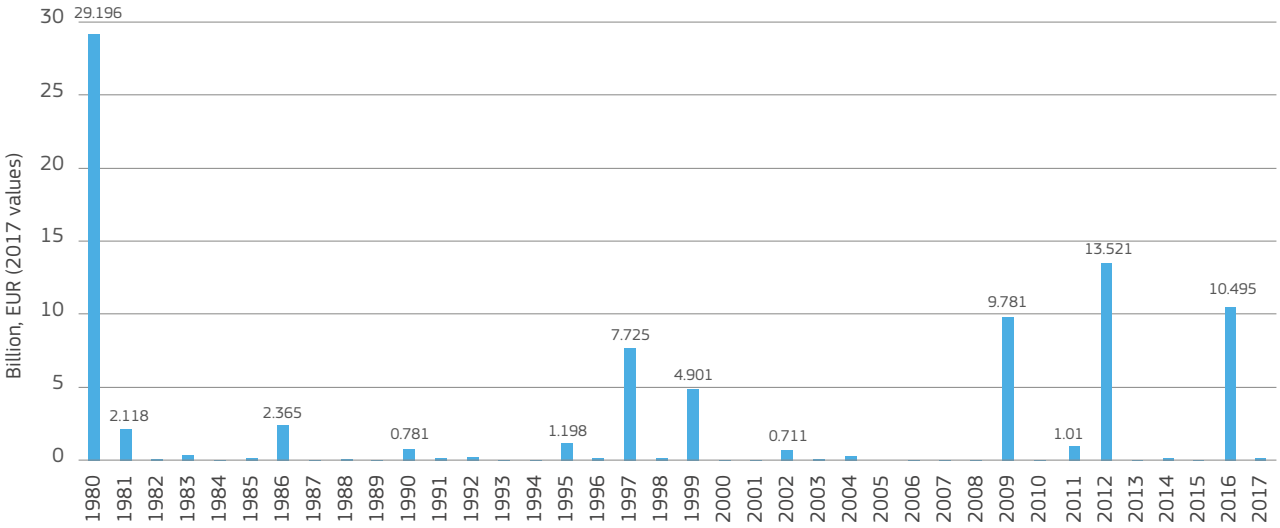


Figure 44. Economic losses caused by geophysical events (earthquakes, tsunamis, volcanic eruptions) in the EU-28, 1980-2017. Source: MunichRe/EEA [368]

[367] The EN Eurocodes are a series of 10 European Standards, EN 1990 - EN 1999, providing a common approach for the design of buildings and other civil engineering works. Available at https://eurocodes.jrc.ec.europa.eu/

[368] Economic losses from climate-related extremes in Europe. The European Environment Agency collects information on fatalities and economic losses from disasters caused by natural hazards. The data is provided by the NatCatSERVICE of the Munich Reinsurance Company. Available at https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2

5.2. Key risk drivers

Exposure and vulnerability are the main drivers of evolving earthquake risk. In Europe, the exposure to earthquakes has been increasing over recent decades (*Figure 45*). Between 1975 and 2015, the population potentially exposed to earthquakes increased by 7%, while the exposed built-up environment increased by 142%. In 2015, approximately a quarter of the EU's population and a quarter of the built-up area were potentially exposed to earthquake scenarios with a return period of 475 years.

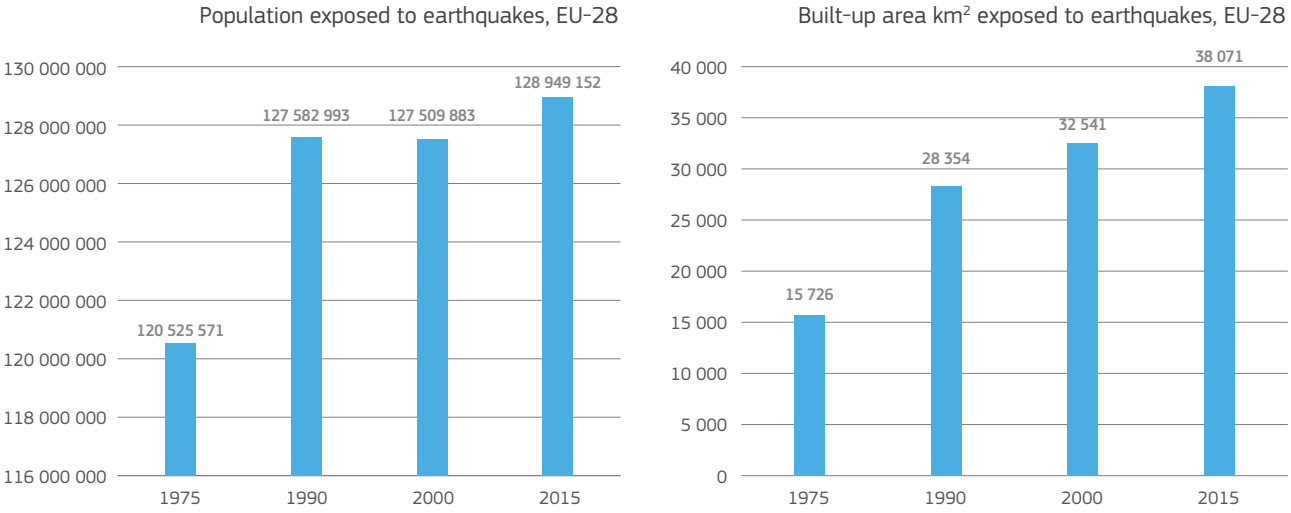


Figure 45. Changes in population and built-up area exposure to earthquakes in the EU-28, 1975-2015. Source: GHSL[369]

In terms of vulnerability, the gradual improvement of seismic standards in buildings in almost all EU Member States has been an important development (*Figure 46*). However, despite the progress achieved, seismic resilience of buildings remains a serious concern. The size of the built-up area in the EU is about 25 billion square metres. Of the current residential building stock, 80% was built before the 1990s, with 40% built before the 1960s. A considerable amount is even older and often classified as cultural heritage. JRC analysis shows that the majority of buildings in the seismic-prone regions of Europe were designed without provisions for earthquake resistance or following moderate-level seismic codes[370].

[369] Ehrlich, D.; Melchiorri, M.; Florczyk, A.J.; Pesaresi, M.; Kemper, T.; Corbane, C.; Freire, S.; Schiavina, M.; Siragusa, A. Remote Sensing Derived Built-Up Area and Population Density to Quantify Global Exposure to Five Natural Hazards over Time. Remote Sens. 2018, 10, 1378.

[370] Tsionis G, Sousa ML, Palermo V, Maio R; Framework for resilience analysis of EU buildings, EUR 29053 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79- 77703-5, doi:10.2760/923762, PUBSY No. 110165.

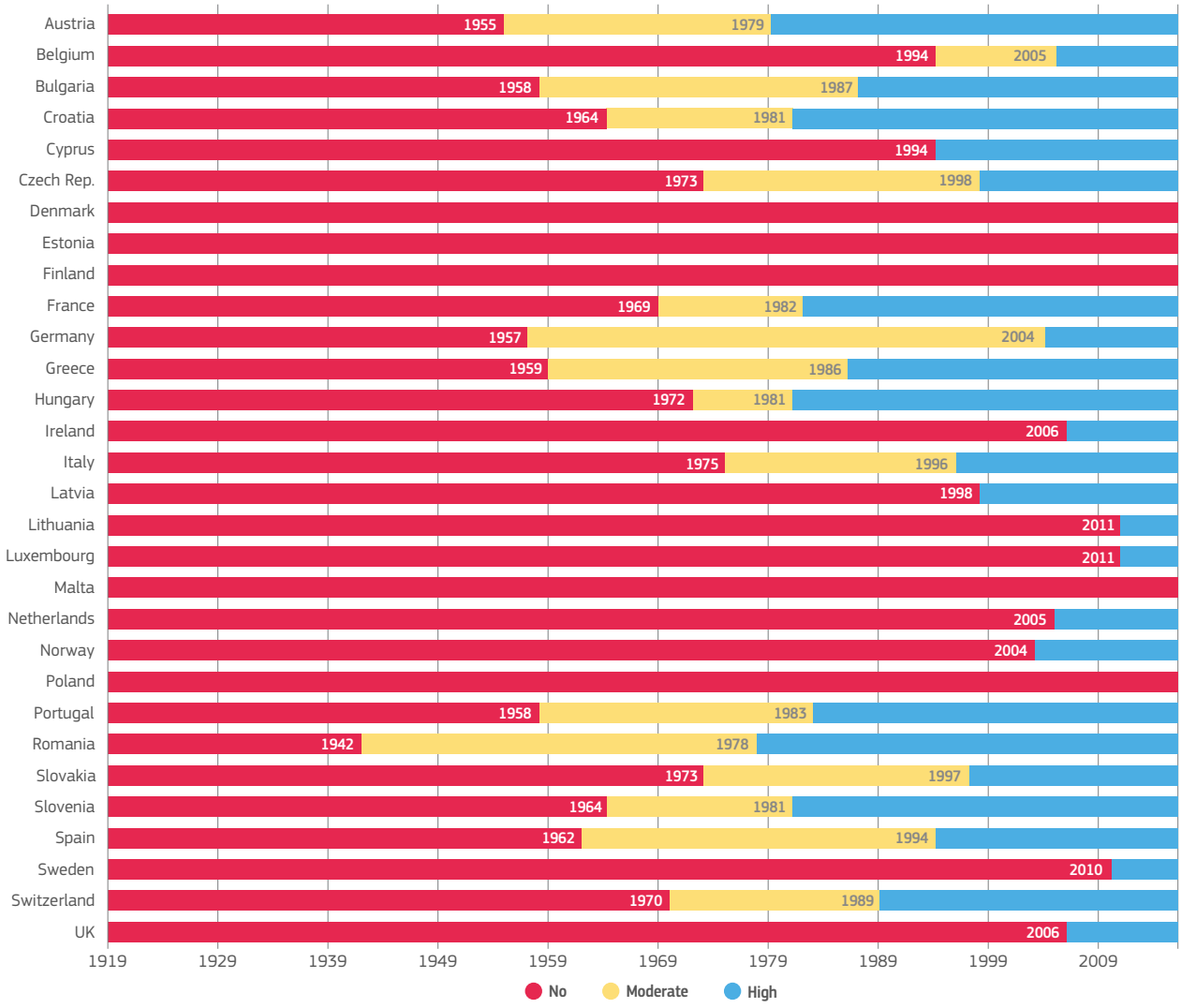


Figure 46. Seismic standards in the EU – developments over time. Source: Palermo et al.[371]

Box 18. Seismic resilience: the case of the 2016 earthquakes in Italy

In 2016, four regions of central Italy - Lazio, Abruzzo, Umbria and Marche – were struck by the Amatrice-Norcia seismic sequence. The impact of these earthquakes highlighted the different levels of resilience of masonry constructions depending on the preventive actions carried out after previous earthquakes. In particular, although damaged, the masonry buildings in the historical centre of Norcia (Umbria region) fared significantly better than those in other regions. The interventions to strengthen buildings carried out after the earthquakes of 1971, 1979 and 1997 greatly helped masonry aggregates in the historical centre to cope with seismic activity, as it sustained limited damage and a low number of collapses.

Source: Sisti R., Di Ludovico M., Borri A., Prota A. (2018)[372]

[371] Palermo V, Tsionis G, Sousa ML. Building stock inventory to assess seismic vulnerability across Europe. JRC Technical reports. 2018 – Publications Office of the European Union. ISBN: 978-92-79-86707-1 DOI: 10.2760/530683

[372] Sisti, Romina & Di Ludovico, M. & Borri, Antonio & Prota, A. (2018). Damage assessment and the effectiveness of prevention: the response of ordinary unreinforced masonry buildings in Norcia during the Central Italy 2016–2017 seismic sequence. Bulletin of Earthquake Engineering. 10.1007/s10518-018-0448-z.

5.3. The geophysical risk in national risk assessments

Twenty countries included seismic risk in their latest submissions of national risk assessments. Nine countries assessed the risk of tsunamis. Six national risk assessments included volcanic eruption or the risk of volcanic ashes, especially due to the experience with the 2010 Eyjafjallajökull eruption in Iceland that caused large-scale disruptions across Europe. Compared to the previous risk assessment cycle, several countries included geophysical risks for the first time, while others analysed them in more detail (e.g. more scenarios, historical data, new models).

Earthquake risk in NRAs 2015

Earthquake risk in NRAs 2018/2019

Tsunami risk in NRAs 2015

Tsunami risk in NRAs 2018/2019

Volcanic risk in NRAs 2015

Volcanic risk in NRAs 2018/2019

On seismic risk, the assessment of likelihood and impact varies from country to country, taking into consideration the different levels of exposure to the risk as well as structural vulnerability. Italy, Bulgaria and Slovenia rate the seismic risk the highest. In contrast, the Netherlands assesses the risk of a natural earthquake as 'somewhat unlikely' with potentially 'limited' damages, while the risk of a human-induced earthquake (i.e. caused by gas extraction) is assessed as 'very unlikely' with 'substantial damages'.

As regards the tsunami risk, it is assessed more widely than in the past risk assessments. In Italy, tsunami risk was introduced among civil protection responsibilities in 2018. The risk is now covered in the national risk assessment, identifying the highest danger along the coasts facing the Ionian Sea. Greece, struck by a tsunami in June 2017, assesses tsunamis induced by earthquakes. Cyprus has developed a quantified estimation of impacts on economic areas and fatalities in the event of a tsunami. Portugal, which saw the most destructive tsunami in Europe caused by Lisbon earthquake in 1775, assesses the tsunami risk as one of low probability. However, if a tsunami occurred near the capital of Lisbon, it would have a high impact. France considers tsunami risk for its Overseas Departments and Territories, and a secondary tsunami – for the shores of the Mediterranean. Ireland and Norway also assess the tsunami risk.

Some Member States mention in their reports measures for managing the geophysical risk. These include methodologies for assessing and mapping the seismic risk, seismic risk awareness-raising measures, training on design and construction of seismic-resistant buildings, and seismic zoning and urban planning. Several good practices emerge, such as the Italian alert system (SiAM) for tsunamis generated by earthquakes in the Mediterranean Sea or the UK *Airways Volcano Watch* – civil contingency aircraft used for atmospheric testing in the UK airspace.

The cross-border dimension of geological risks is taken into consideration by several countries. Some of them also report on cross-border cooperation in the field (e.g. early detection of earthquakes supported by the Romania-Bulgaria Interreg cross-border cooperation programme).

5.4. Addressing geophysical risks: EU actions

Despite some progress made in recent years, seismologists still cannot predict in the short-term the magnitude, date, time or location of seismic events. While there are phenomena – known as precursors – that might give an

indication or a warning of an impending event[373], they are not sufficient to forecast a volcanic eruption. Contrary to earthquakes and volcanic eruptions, tsunamis are usually the result of other events, such as earthquakes, submarine landslides or volcanic activity in the sea or near the coast. This means that there is some time between the event triggering the tsunami and its impact, though it can be only minutes.

Considering that it is not possible to avoid the occurrence of earthquakes, volcanic eruptions or tsunamis, nor to fully eliminate the presence of people and property in some hazardous areas, risk mitigation policies focus on:

- increasing resilience (societal and structural);
- reducing vulnerabilities (structural, physical and social); and
- minimising the exposure of the elements at risk.

Regarding seismic risk, ensuring the safety of the built environment, including structural integrity, is a significant area of action, addressed through building codes and building retrofit policies. The European Commission supports the development of the European building standards – Eurocodes[374], of which Eurocode 8 (EN 1998) guides the design of buildings, bridges, silos, tanks, pipelines, foundations, towers, masts and chimneys in seismic areas. These standards allow for new buildings to be better designed and, to a certain extent, existing structures to be renovated and adapted, ensuring that, in the event of earthquake, lives are protected, damage is limited and civil protection structures remain operational. Special structures, such as nuclear power plants, offshore structures and large dams, are outside the scope of EN 1998.

The Eurocodes recognise the responsibility of regulatory authorities in each Member State to determine values related to safety matters at a national level. Nevertheless, the Commission recommends Member States to diverge from recommended values only where this is justified according to geographical, geological or climatic conditions or specific levels of protection, and to notify those deviations to the Commission. According to the JRC report 'The State of harmonised use of the Eurocodes'[375], seismic zone maps show discontinuities in the seismic levels at countries' borders due to different national practices, making it difficult to harmonise the use of Eurocodes in neighbouring regions of different Member States.

Besides setting building standards for seismic resilience, the EU also supports investments aimed at reducing the risks. The European Regional Development Fund and Cohesion Fund provide significant funding to Member States to enable them to be resilient to and prepared for geophysical risks, as well as for cross-border and transnational cooperation in this area. The EU Solidarity Fund offers financial aid for emergency and post-disaster reconstruction operations. In 2017-2019, the EU Solidarity Fund supported two Member States, Greece and Italy, allocating over EUR 1.2 billion to deal with damages caused by earthquakes in 2017 and 2018.

Looking forward, continued action is necessary to achieve higher safety standards in areas prone to geophysical risk. This should include:

- enforcing and improving building codes with appropriate seismic design and construction requirements;
- targeted measures to address vulnerability of existing critical infrastructure (e.g. hospitals, schools, emergency units, etc.) and cultural heritage buildings and sites;
- development of early warning systems; and
- awareness-raising activities.

[373] Volcanic eruptions are sometimes preceded by, among other things, i) soil fractures, ii) deformation of the volcanic building, iii) changes in the emission of gases, iv) changes in the magnetic field surrounding the volcanic edifice, v) increased and altered composition of gaseous emissions from craters, and vi) changes in the physico-chemical characteristics of the water.

[374] See https://eurocodes.jrc.ec.europa.eu/

[375] Sousa, M.L., Dimova, S. Athanasopoulou, A., Iannaccone, S. Markova, J., *State of harmonised use of the Eurocodes*, EUR 29732 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-02911-3, doi:10.2760/22104, JRC115181.

6. Epidemics/pandemics

6.1. The risk and trends

At any time, there can be dozens of infectious disease outbreaks happening around the globe[376]. In an increasingly interconnected world, they can quickly spread from one country to another and evolve into large-scale health emergencies. There has been a renewed focus on infectious disease due to recent outbreaks of emerging and re-emerging infectious diseases, such as coronavirus disease (COVID-19), severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), the Ebola virus disease, measles, avian and pandemic influenza, dengue and the Zika virus disease.

Box 19. Emerging or re-emerging infectious diseases

An emerging or re-emerging infectious disease is one that (i) arises through evolution or change in existing pathogens, (ii) was previously unrecognised or (iii) is already known but spreads to new geographic areas, or new populations, or reappears after having been eradicated.

Worldwide, novel pathogens continue to emerge: since 1970, over 1 500 new pathogens have been discovered[377]. A large proportion of them are detected in animals and can subsequently be transmitted to humans[378]. Zoonotic diseases have long been a source of particular concern due to their potential to cause an epidemic. The possibility of a new zoonosis emerging is high as an increase in the global population, human intrusion into natural ecosystems and intensive agriculture are driving increased rates of interspecies contacts and the interchange of pathogens[379] [380] [381] [382].

Whichever the causative agent, urbanisation, intensive travel and trade flows facilitate the spread of infections nowadays, enabling them to be imported and become endemic in new locations facilitated by climate and environmental changes. At the same time, decreasing vaccination rates and widespread antimicrobial resistance witnessed across the globe, along with an ageing population in Europe, contributes to the increased vulnerability of people to infectious diseases. The capacity of healthcare systems to detect and control epidemics differs widely, however, and in the interconnected world '*global health security is only as strong as its weakest link*'[383].

While scientific and technological developments offer new solutions to address public health issues, they also create the possibility for disease-causing microorganisms to be engineered or recreated in laboratories and used for malicious purposes[384] [385]. Experts estimate that future terrorist threats are likely to come from the use of biological and chemical weapons[386].

[376] World Health Organization. Outbreaks: behind the headlines – 2 August 2018 – available at https://www.who.int/emergencies/outbreaks-behind-the-headlines

[377] https://www.who.int/emergencies/diseases/managing-epidemics-interactive.pdf

[378] Scientists estimate that more than 6 out of every 10 known infectious diseases in people can be spread from animals, and 3 out of every 4 new or emerging infectious diseases in people come from animals. See, for example, https://www.cdc.gov/onehealth/basics/zoonotic-diseases.html

[379] Carrasco-Hernandez R., Rodrigo Jácome, Yolanda López Vidal, Samuel Ponce de León. Are RNA Viruses Candidate Agents for the Next Global Pandemic? A Review, *ILAR Journal*, Volume 58, Issue 3, 2017, P. 343–358, https://doi.org/10.1093/ilar/ilx026

[380] Brown C. Spillover: Animal Infection and the Next Human Pandemic. Emerging Infectious Diseases. 2013. Vol. 19 No.2. https://dx.doi.org/10.3201/eid1902.121694

[381] FAO. Mapping supply and demand for animal-source foods to 2030. 'Animal Production and Health Working Paper'. No. 2. Rome, 2011 http://www.fao.org/docrep/014/i2425e/i2425e00.pdf

[382] Wang LF, Crameri G. Emerging zoonotic viral diseases. Revue Scientifique et Technique (International Office of Epizootics), 01 August 2014, 33(2):569-581 DOI: 10.20506/rst.33.2.2311

[383] WHO Director-General Dr Tedros. Compelling priorities for global health. Remarks at Columbia University, New York City, USA. 19 September 2017 – available at https://www.who.int/dg/speeches/2017/compelling-priorities-health/en/

[384] Global Preparedness Monitoring Board. A World at Risk. Annual report on global preparedness for health emergencies. 2019 – available at https://apps.who.int/gpmb/assets/annual_report/GPMB_annualreport_2019.pdf

[385] World Health Organization. Preparedness for the deliberate use of biological agents. A rational approach to the unthinkable. – May 2002 // https://www.who.int/csr/resources/publications/deliberate/whacdscsreph200216.pdf?ua=1

[386] Member States' Preparedness for CBRN Threats. Study commissioned by the European Parliament. April 2018 – available at http://www.europarl.europa.eu/RegData/etudes/STUD/2018/604960/IPOL_STU(2018)604960_EN.pdf

All of these factors contribute to the increasing likelihood of epidemics and pandemics[387]. In 2018, a report prepared for the Global Preparedness Monitoring Board[388] concluded that there was a 'very real threat of a rapidly moving, highly lethal pandemic of a respiratory pathogen killing 50 to 80 million people and wiping out nearly 5% of the world's economy.'[389] At the time of writing this document, Europe and the world were already confronted with the manifestation of this risk – the COVID-19 pandemic. The following section takes a closer look at this unprecedented public health emergency event.

6.2. A global pandemic: the case of the COVID-19 disease[390]

Coronaviruses are a large family of viruses known to infect various animals and humans. In people, they can cause illness ranging from the common cold to more severe diseases. Zoonotic (i.e. transmitted between animals and humans) coronaviruses have in recent years caused human outbreaks, such as SARS in 2003 and MERS since 2012[391].

At the end of December 2019, a novel coronavirus (SARS-CoV-2), not previously known to infect humans, was identified in Wuhan, China. It is believed to have been originally transmitted to people from an animal, but the source had not been established at the time of writing[392]. The virus can be transmitted from person to person via droplets and fomites, i.e. objects or materials likely to carry infection, such as clothes, utensils, and furniture. As there is no pre-existing immunity in the population against the new coronavirus, potentially everyone is susceptible to infection. For most infected people, the disease is mild, but in more severe cases, it can lead to pneumonia and death[393]. The likelihood of hospitalisation, severe illness and death is significantly higher in people over 65 and those with pre-existing health conditions. At the time of writing, neither specific treatment nor vaccines were available to fight against SARS-CoV-2 infection. It was also not yet clear what the long-term effects of the disease on infected patients will be.

By 11 March 2020, when the World Health Organisation (WHO) declared a global pandemic, the virus has spread to 114 countries, infected more than 118 000 people and caused 4 281 deaths[394]. By that time, Europe had become the new epicentre of the disease[395]. The number of cases and deaths was growing exponentially in all Member States. Confronted with the rapid spread of the infection and the threat of exceeding the capacity of healthcare systems, Member States introduced social distancing measures as well as travel and trade restrictions.

In some Member States, the public health emergency coincided with other disaster events and concurrent pressures. In Croatia, the strongest earthquake in 140 years hit in the midst of the pandemic, triggering the evacuation of hospitals. In the Mediterranean, increased migration flows at the time of the pandemic posed further challenges for containing the spread of the virus. In some countries, the ongoing influenza season[396] and dengue

[387] Johns Hopkins Center for Health Security. Preparedness for a High-Impact Respiratory Pathogen Pandemic –The report commissioned by and prepared for the Global Preparedness Monitoring Board – September 2019 – available at https://apps.who.int/gpmb/assets/thematic_papers/tr-6.pdf

[388] The Global Preparedness Monitoring Board (GPMB) was convened in 2018 by the World Health Organization and the World Bank Group. The GPMB's mandate is to apprise key policymakers and the world of system-wide progress towards increased preparedness and response capacity for disease outbreaks and other emergencies with health consequences.

[389] Global Preparedness Monitoring Board. A World at Risk. Annual report on global preparedness for health emergencies, 2019. Available at https://apps.who.int/gpmb/assets/annual_report/GPMB_annualreport_2019.pdf

[390] This section is based on information available as of 2 April 2020.

[391] The European Centre for Disease Prevention and Control. Disease background of COVID-19. Available at https://www.ecdc.europa.eu/en/factsheet-health-professionals-coronaviruses

[392] Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19) – 16-24 February 2020 – available at https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf

[393] The European Centre for Disease Prevention and Control. Coronavirus disease 2019 (COVID-19) pandemic: increased transmission in the EU/EEA and the UK – seventh update. Rapid Risk Assessment – available at https://www.ecdc.europa.eu/sites/default/files/documents/RRA-seventh-update-Outbreak-of-coronavirus-disease-COVID-19.pdf

[394] WHO Director-General's opening remarks at the media briefing on COVID-19 – 11 March 2020 – available at https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

[395] WHO announces COVID-19 outbreak a pandemic. 12 March 2020 – available at http://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/news/news/2020/3/who-announces-covid-19-outbreak-a-pandemic

[396] The European Centre for Disease Prevention and Control. Coronavirus disease 2019 (COVID-19) pandemic: increased transmission in the EU/EEA and the UK – seventh update. Rapid Risk Assessment – available at https://www.ecdc.europa.eu/sites/default/files/documents/RRA-seventh-update-Outbreak-of-coronavirus-disease-COVID-19.pdf

epidemic in several EU outermost regions put an extra strain on hospitals and intensive care units.

Even in advanced healthcare systems and with special measures taken, the pandemic created immense stress. The capacity of intensive care units was exceeded in some of the hardest-hit places. Countries struggled with widespread disruptions in supply of critical resources such as ventilators, testing materials and personal protective equipment. Ensuring occupational safety for medical staff has been a challenge, as COVID-19 cases have been identified among healthcare workers[397]. Faced with the shortages of personal protective equipment and medicines, some Member States have taken national measures restricting their export, thus preventing essential goods from reaching other affected areas across Europe[398].

Despite challenges and frictions encountered, the EU, Member States, regions and cities also showed solidarity by helping each other to deal with the crisis. Within the UPCM framework, Member States donated medical and personal protective equipment, took on patients from neighbouring countries into intensive care and sent medical staff to the worst affected places[399]. The Commission and Member States joined forces to procure medical and protective equipment[400]. As a safety net, the European reserve of medical equipment – the rescEU stockpile – was created under the UCPM[401]. The EU Emergency Support Instrument was activated to support the healthcare sector during the emergency with EUR 2.7 billion in funding[402]. The EU Solidarity Fund was revised to include public health crises within the scope of intervention. Funding was allocated to research projects on coronavirus vaccines, diagnosis and treatment. Last but not least, the UCPM helped with repatriating thousands of EU citizens stranded abroad. Looking forward, the EU will be investing EUR 9.4 billion in strengthening preparedness for major cross-border health threats and resilience of healthcare systems through its new health programme EU4Health 2021-2027.

At the time of writing, the coronavirus pandemic has not receded. The number of infections and deaths have continued to grow, with new outbreaks seen in Europe and across the world, notwithstanding the mitigation measures taken and the capacity of strengthened health systems to tackle the disease. By the end of August 2020, the number of infected people globally exceeded 25 million and more than 800 000 deaths were recorded. In the EU-27, the human toll included nearly 2 million infected people and more than 130 000 fatalities[403].

In addition to its dire impacts on life and health, the coronavirus outbreak has also been a major shock to the EU and global economies. The spread of the virus and stringent containment measures caused disruption to global supply chains, volatility in financial markets, consumer demand shocks and negative impacts in key sectors like travel and tourism. The GDP outturn for the first quarter of 2020 showed that the European economy had slipped into contraction after almost 7 years of uninterrupted growth. Compared to the last quarter of 2019, GDP contracted by 3.6% in the euro area, and fell by 3.2% in the EU. The Summer 2020 European Economic Forecast projected that the EU economy would contract by 8.3% in 2020 and grow by 5.8% in 2021[404]. However, a lot of uncertainty surrounds the outlook as the duration and scale of the pandemic remain unpredictable. To soften and counterbalance the economic and social effects of the COVID-19 outbreak, the Commission put forward the recovery instrument – Next Generation EU – offering Member States financial support of EUR 750 billion for

[397] The European Centre for Disease Prevention and Control. Coronavirus disease 2019 (COVID-19) pandemic: increased transmission in the EU/EEA and the UK – sixth update. Rapid Risk Assessment – available at https://www.ecdc.europa.eu/sites/default/files/documents/RRA-sixth-update-Outbreak-of-novel-coronavirus-disease-2019-COVID-19.pdf

[398] COM(2020) 112 final.

[399] The European Commission. Coronavirus: European Solidarity in action. Available at https://ec.europa.eu/info/live-work-travel-eu/health/coronavirus-response/coronavirus-european-solidarity-action_en

[400] The European Commission. Public health. Available at https://ec.europa.eu/info/live-work-travel-eu/health/coronavirus-response/public-health_en

[401] COVID-19: Commission creates first ever rescEU stockpile of medical equipment. Press release, 19 March 2020 – Available at https://ec.europa.eu/commission/presscorner/detail/en/ip_20_476

[402] The European Commission. European Union Emergency Support Instrument for the healthcare sector - questions and answers. 2 April 2020 – available at https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_577

[403] On 31 August 2020, in the EU-27, there were 1,866,791 confirmed cases and the death toll stood at 139,793 fatalities. Source: European Centre for Disease Prevention and Control (ECDC) – available at https://qap.ecdc.europa.eu/public/extensions/COVID-19/COVID-19.html

[404] The European Commission. European Economic Forecast. Summer 2020 (Interim). Institutional paper – July 2020 - Luxembourg: Publications Office of the European Union, 2020 – ISBN 978-92-76-16321-3 ISSN 2443-8014 doi:10.2765/828014.

action to recover, repair and emerge stronger from the crisis[405].

The COVID-19 pandemic is a worst-case disaster scenario. Unfortunately, it might not be a unique event. There are numerous pathogens with the potential to cause a pandemic and there is always a possibility that the next global health crisis could be caused by an agent that is currently unknown[406]. In many respects, the COVID-19 pandemic is a typical example of emerging risks and the challenges that such new risks pose for disaster risk management. The pandemic is also a litmus test of our general preparedness for large-scale disaster events. There will be many lessons that need to be learned about:

- the fitness of existing national/EU/global instruments;
- readiness and resilience of critical healthcare infrastructure;
- production, supply and stockpiling of critical medical equipment;
- protection of the most vulnerable groups in society;
- multi-sector and multilateral cooperation in complex emergencies;
- communication in times of disinformation; and
- the role that new technologies can play in managing disasters.

6.3. Key risk drivers

Besides the COVID-19 disease, there are multiple other emerging and re-emerging infectious diseases requiring increasing attention from the European health authorities. Emerging diseases include the Venezuelan equine encephalitis, Mayaro and Severe fever with thrombocytopenia syndrome (SFTS). New developments have also been observed regarding multiple vector-borne diseases[407].

While the incidence of vector-borne diseases in Europe is much lower than in some other regions of the world, they are rising and their distribution is spreading. The most common vector-borne diseases in Europe are tick-borne encephalitis and Lyme disease. Approximately 85 000 cases of Lyme disease are reported each year, with an increasing number of cases witnessed in Northern Europe[408]. This trend is linked to i) milder winters, ii) warmer summers, iii) lower seasonal variation of temperatures, iv) longer vegetation seasons, and v) human/agricultural factors, such as land-use pattern.

As regards mosquito-borne diseases, outbreaks of chikungunya, dengue, malaria and West Nile virus have occurred in recent years. In addition to imported cases, local transmission of these diseases has also been observed in continental Europe. Trade and travel play a significant role in the introduction and dispersion of vectors and viruses[409]. Moreover, it is anticipated that warmer temperatures and changes in precipitation brought by climate change will create further favourable conditions for outbreaks of vector-borne diseases, with the risk of these diseases becoming endemic in some areas of Europe[410] [411] (*Figure 47, Figure 48*).

[405] COM(2020) 456 final.

[406] Johns Hopkins Center for Health Security. The Characteristics of Pandemic Pathogens – 2018 – available at http://www.centerforhealthsecurity.org/our-work/pubs_archive/pubs-pdfs/2018/180510-pandemic-pathogens-report.pdf

[407] Vector-borne diseases are transmitted by bites of vectors such as mosquitoes, ticks, and sandflies that can carry pathogens from person to person and place to place.

[408] European Centre for Disease Prevention and Control. Vector-borne diseases // https://www.ecdc.europa.eu/en/climate-change/climate-change-europe/vector-borne-diseases

[409] Semenza JC, Sudre B, Miniota J, Rossi M, Hu W, Kossowsky D, et al. (2014) International Dispersal of Dengue through Air Travel: Importation Risk for Europe. PLoS Negl Trop Dis 8(12): e3278. https://doi.org/10.1371/journal.pntd.0003278

[410] Semenza Jan C. and Jonathan E. Suk. Vector-borne diseases and climate change: a European perspective - FEMS Microbiology Letters – Volume No. 365. Issue No. 2. January 2018 // https://academic.oup.com/femsle/article/365/2/fnx244/4631076

[411] The European Centre for Disease Prevention and Control. Emerging and Vector-borne Diseases Programme. Available at https://www.ecdc.europa.eu/en/about-uswho-we-aredisease-programmes/emerging-and-vector-borne-diseases-programme

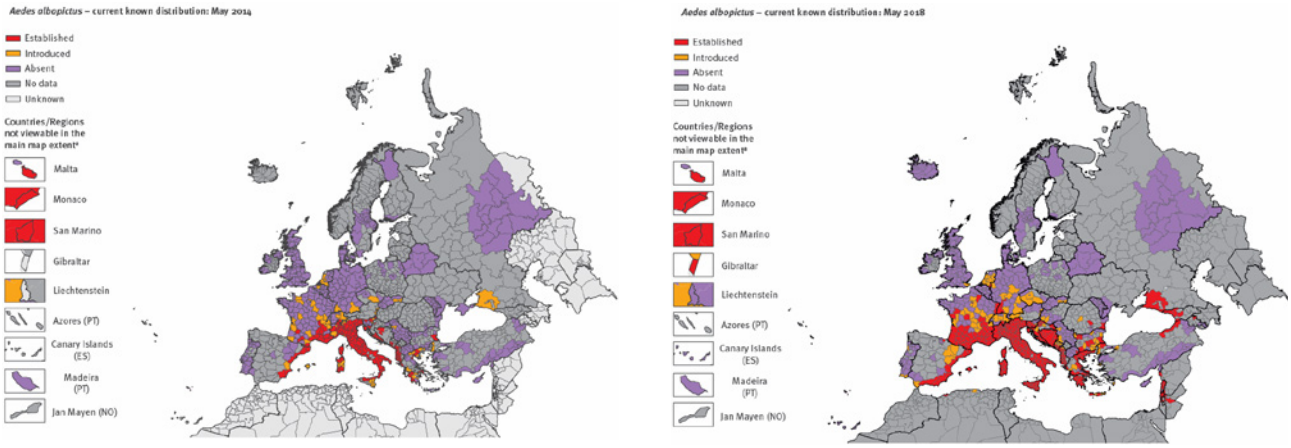


Figure 47. Distribution of Aedes albopictus (tiger mosquito transmitting vector-borne diseases, such as dengue and chikungunya) in 2014 and 2018[412]

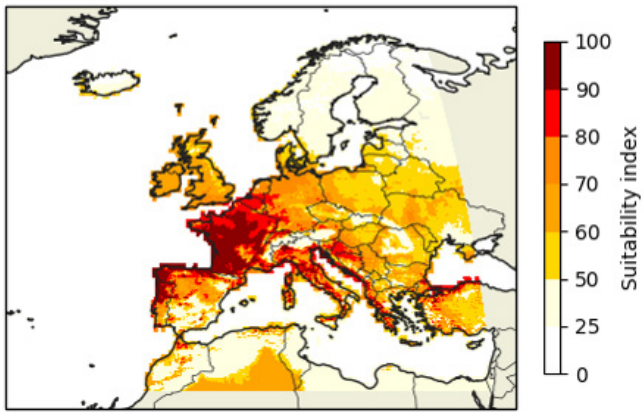


Figure 48. Projected climatic suitability for the Aedes albopictus in Europe averaged over the future period 2031-2060 with RCP4.5 [413]

Besides emerging diseases, 'old' infections are making a comeback. One prominent example is measles. Measles is one of the most contagious of all known infectious diseases: 90% of non-immune people exposed to an infected individual will contract the disease. Despite the availability of a vaccine and despite being a disease 'under elimination', measles is now considered a major threat to health across Europe. A large epidemic of measles has affected the region in the past few years (*Figure 49*). In total, some 150 000 cases of measles have been reported by EU/EEA Member States over the last decade. The risk of contracting measles is mainly driven by suboptimal vaccination rates in most European countries and a large pool of susceptible individuals. A vaccination coverage of 95% for both doses of measles-containing vaccine is necessary in order to obtain herd immunity and to, eventually, eradicate the disease. In 2018, only five countries achieved this target compared to 14 countries in 2007. The intense movement of people enables the disease to spread. Data shows that most measles outbreaks in Europe are imported from another European country. There is a high risk of continued widespread circulation of measles in the near future, as long as gaps in vaccination coverage and immunity remain[414].

[412] Gossner Céline M, Ducheyne Els, Schaffner Francis. Increased risk for autochthonous vector-borne infections transmitted by Aedes albopictus in continental Europe. Euro Surveill. 2018;23(24):pii=1800268. https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2018.23.24.1800268

[413] Copernicus Climate Change Service. Climatic suitability for the presence and seasonal activity of the Aedes albopictus mosquito for Europe derived from climate projections – 26 November 2019 – available at https://cds.climate.copernicus.eu/cdsapp#!/dataset/sis-health-vector?tab=overview

[414] The European Centre for Disease Prevention and Control. Who is at risk for measles in the EU/EEA? Identifying susceptible groups to close immunity gaps towards measles elimination – Risk assessment – 28 May 2019 – available at https://www.ecdc.europa.eu/sites/default/files/documents/RRA-Measles-EU-EEA-May-2019.pdf

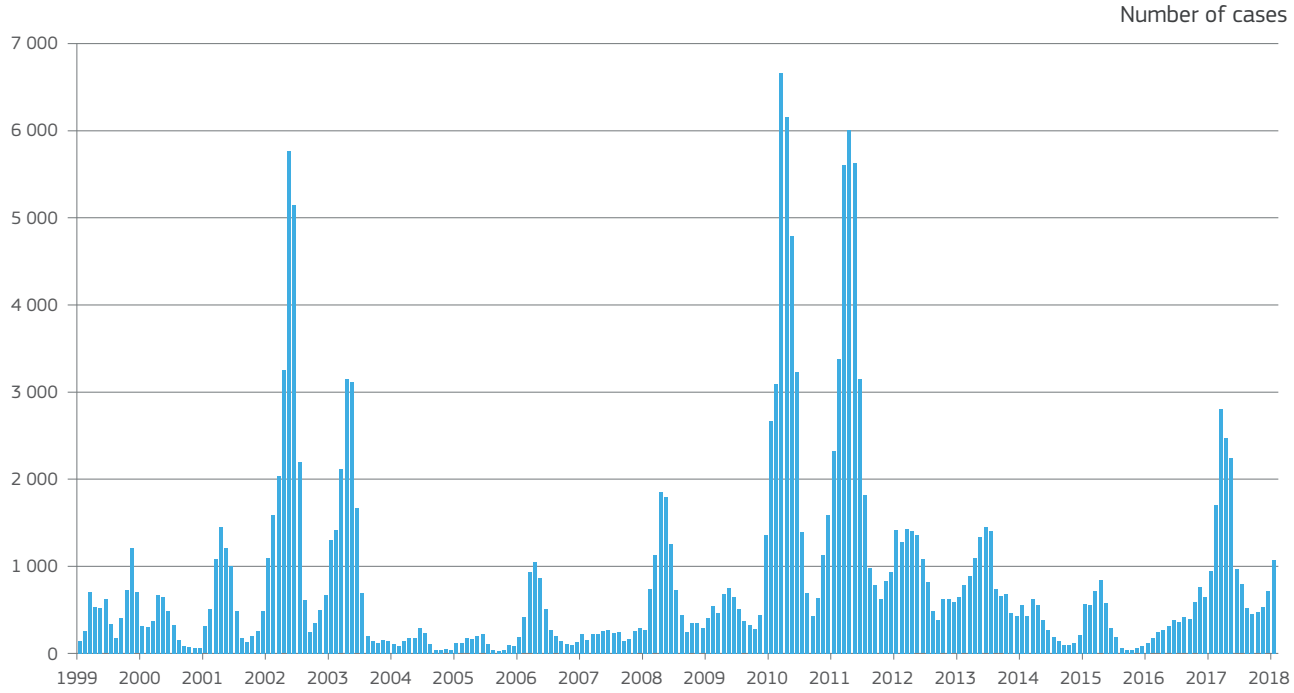


Figure 49. Number of monthly reported measles cases, EU/EEA countries, 1999–2018[415]

There are a number of reasons for insufficient and decreasing vaccination coverage in Europe. One important factor is vaccine hesitancy[416]. Opposition to vaccination is not restricted to measles; it also concerns other vaccine-preventable diseases. A survey carried out in 2018 revealed that the Europeans have among the lowest levels of confidence in the safety and effectiveness of vaccines in the world. Misconceptions about vaccination have shifted the public focus away from its benefits towards distrust in science and fear of possible side effects[417]. Besides vaccine hesitancy, suboptimal organisation of vaccination services and vaccine supply have also been a challenge for national immunisation programmes. Member States have encountered multiple vaccine shortages[418]. Production capacities in the EU are limited. Unpredictable demand and insufficient incentives for the pharmaceuticals industry to make the necessary investments hinder the research, development and production of new and existing vaccines[419].

A public health emergency on an international scale could also occur as a result of an outbreak of a foodborne disease. One example was the outbreak of *E. coli* infection in 2011, which killed 55 people and made nearly 4 000 individuals from 16 countries in Europe and North America sick[420]. Foodborne diseases are contracted through consuming food or liquids that have been contaminated with bacteria, parasites, viruses or toxins that may be produced by some bacteria during their growth. In Europe, the reported causes of foodborne diseases are most often bacteria because they are commonly subjected to surveillance, for example, *Campylobacter, Salmonella, Yersinia, E. coli, Listeria and* monocytogenes. Each year, over 350 000

[415] The European Centre for Disease Prevention and Control. Risk of measles transmission in the EU/EEA – Rapid risk assessment – 23 March 2018 – available at https://www.ecdc.europa.eu/sites/default/files/documents/Measles-rapid-risk-assessment-European-Union-countries_0.pdf

[416] Vaccine hesitancy refers to a reluctance or refusal to vaccinate against vaccine-preventable diseases despite the availability of immunisation services.

[417] State of Vaccine Confidence in the EU 2018. A report for the European Commission by Prof. Heidi Larson, Dr. Alexandre de Figueiredo, Emilie Karafillakis and Mahesh Rawal. – Luxembourg: Publications Office of the European Union, 2018 – available at https://ec.europa.eu/health/sites/health/files/vaccination/docs/2018_vaccine_confidence_en.pdf

[418] Council Recommendation of 7 December 2018 on strengthened cooperation against vaccine-preventable diseases – 2018/C 466/01 – available at http://data.consilium.europa.eu/doc/document/ST-14152-2018-REV-1/en/pdf

[419] The European Commission. Questions and Answers: Global Vaccination Summit – 9 September 2019 – available at https://ec.europa.eu/commission/presscorner/detail/en/qanda_19_5538

[420] WHO. Public health advice on food safety emergencies and outbreaks of foodborne disease – Available at http://www.euro.who.int/en/health-topics/disease-prevention/food-safety/areas-of-work/public-health-advice-on-food-safety-emergencies-and-outbreaks-of-foodborne-disease

cases of these infections are reported in the EU, but the real number is likely to be higher[421]. Some cases are fatal: in 2018, listeriosis and salmonellosis caused nearly 350 deaths. While there had been significant progress over recent years in reducing the burden of foodborne illnesses in the EU, this positive trend has recently stalled. A number of factors help spread foodborne illnesses: i) increased international food and animal trade, ii) the growing complexity of the food chain, iii) increased travel opportunities, iv) changes in agricultural practices, v) new methods of food production, and vi) changes in consumer behaviour. A special concern is foodborne outbreaks with antibiotic-resistant strains. Data shows that antimicrobials used to treat common foodborne illnesses are becoming less effective[422].

In general, antimicrobial resistance is a major public health issue both in the EU and globally. Antimicrobial resistance occurs when microorganisms such as bacteria, viruses, fungi and parasites change in ways that enable them to withstand the action of antimicrobial drugs. As a result, the medications used to cure the infections become ineffective, and infections with antimicrobial-resistant microorganisms persist and may spread to others[423]. Such infections often result in worse patient outcomes and sometimes death. The main cause of antimicrobial resistance is the misuse and overuse of antimicrobials in humans as well as in animals, especially those reared for food production. Other causes include deficiencies in infection prevention and control in healthcare settings[424], and international travel, which can help disseminate antimicrobial resistance[425].

In Europe, the antimicrobial resistance situation varies widely depending on the bacterial species, antimicrobial group and geographical region. In general, lower resistance percentages are reported by countries in northern Europe while higher percentages are reported in southern and eastern Europe[426]. In the EU, resistance to key antimicrobial groups increased between 2005 and 2015[427]. Some 33 000 people die every year as a direct consequence of infections with antibiotic-resistant bacteria. It is estimated that antimicrobial resistance in the EU costs EUR 1.5 billion per year in healthcare costs and productivity losses[428]. Incidences of infections resistant to multiple antimicrobial drugs and last-resort treatments[429] have been rising. The consumption of specific antibiotics used for treating multidrug-resistant bacterial infections almost doubled between 2010 and 2014[430]. Projections suggest that if no effective action is taken, antimicrobial resistance to second-line antibiotics in the EU/EEA will be 72% higher in 2030 compared to 2005[431]. When last-line antibiotics are no longer effective, it is extremely difficult or, in many cases, impossible to treat infected patients. While the antimicrobial resistance phenomenon has been growing, the discovery, development, manufacture and marketing of new antimicrobials has significantly slowed down over the past 20 years[432]. This has raised fears that if these trends continue, we could potentially be without effective antibiotics for several types of microorganisms in the future.

[421] The European Food Safety Authority. Foodborne zoonotic diseases – available at https://www.efsa.europa.eu/en/topics/topic/foodborne-zoonotic-diseases

[422] The European Food Safety Authority and European Centre for Disease Prevention and Control. The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2017 – 19 November 2018 – available at https://www.ecdc.europa.eu/sites/portal/files/documents/zoonoses-%20food-borne-outbreaks-surveillance-2017.pdf

[423] WHO. Antimicrobial resistance. Available at https://www.who.int/antimicrobial-resistance/en/

[424] COM(2017) 0339.

[425] Arcilla Maris S, Jarne M van Hattem, Manon R Haverkate, Martin C J Bootsma, Perry J J van Genderen, Abraham Goorhuis, et al. Import and spread of extended-spectrum β-lactamase-producing Enterobacteriaceae by international travellers (COMBAT study): a prospective, multicentre cohort study. The Lancet Infectious Diseases. 1 January 2017, Volume 17, ISSUE 1, P.78-85, DOI: https://doi.org/10.1016/S1473-3099(16)30319-X

[426] The European Centre for Disease Prevention and Control. Surveillance of antimicrobial resistance in Europe 2017 – Surveillance report – 15 November 2018. Available at https://www.ecdc.europa.eu/en/publications-data/surveillance-antimicrobial-resistance-europe-2017

[427] The European Centre for Disease Prevention and Control and OECD. Antimicrobial Resistance. Tackling the Burden in the European Union – Briefing note for EU/EEA countries – 2019. Available at https://www.oecd.org/health/health-systems/AMR-Tackling-the-Burden-in-the-EU-OECD-ECDC-Briefing-Note-2019.pdf

[428] The European Commission. AMR: a major European and Global challenge. Available at https://ec.europa.eu/health/amr/sites/amr/files/amr_factsheet_en.pdf

[429] Treatments that are used after the failure of all other options to produce an adequate response in the patient.

[430] The European Commission. EU Action on Antimicrobial Resistance. Available at https://ec.europa.eu/health/amr/antimicrobial-resistance_en

[431] The European Centre for Disease Prevention and Control and OECD. Antimicrobial Resistance. Tackling the Burden in the European Union – Briefing note for EU/EEA countries – 2019. Available at https://www.oecd.org/health/health-systems/AMR-Tackling-the-Burden-in-the-EU-OECD-ECDC-Briefing-Note-2019.pdf

[432] COM(2017) 0339

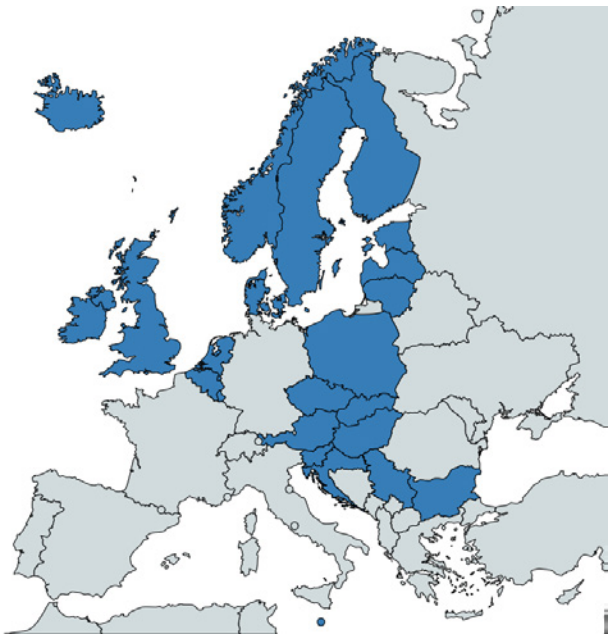
Box 20. Burden of communicable diseases in Europe

The European Centre for Disease Prevention and Control developed a tool that enables different infectious disease threats to be assessed and ranked based on their impact on people's health in EU/EEA countries[433]. The tool is intended to support public health agencies and policy makers in making evidence-based decisions on preventing and controlling infectious diseases.

The basis of the methodology is a composite health measure – the disability-adjusted life year (DALY). It measures the impact of a disease in terms of the number of years lived with disability following the onset of a disease and the impact of the number of years of life lost due to premature death compared with a standardised life expectancy. The software application allows disability-adjusted life years (DALYs) to be calculated for a selection of 117 communicable diseases and six types of healthcare-associated infections.

The methodology has been applied to rank 31 selected infectious diseases. Influenza topped the list with 30% of total burden measured in DALYs, followed by tuberculosis and HIV[434]. Recently, another study[435] was carried out to estimate the burden of infections caused specifically by antibiotic-resistant bacteria. The findings suggest that the burden of infections with bacteria resistant to antibiotics can be compared to that of influenza, tuberculosis and HIV/AIDS combined, and increased between 2007 and 2015. The study also found that 75% of this burden of disease was due to antimicrobial-resistant healthcare-associated infections and that it varied greatly between countries, thus highlighting the need for prevention and control strategies that are tailored to the needs of each country.

6.4. Epidemics/pandemics in national risk assessments



Epidemic risk in NRAs 2015

Epidemic risk in NRAs 2018/2019

[433] The European Centre for Disease Prevention and Control. About burden of communicable disease. Available at https://www.ecdc.europa.eu/en/all-topics-zburden-communicable-diseases/about-burden-communicable-disease

[434] Cassini A., Colzani E., Pini A. et al. Impact of infectious diseases on population health using incidence-based disability-adjusted life years (DALYs): results from the Burden of Communicable Diseases in Europe study, European Union and European Economic Area countries, 2009 to 2013. Eurosurveillance. Volume 23. Issue 16. – 19 April 2018 – https://doi.org/10.2807/1560-7917.ES.2018.23.16.17-00454

[435] Cassini A.; Diaz Högberg L.; Plachouras D.; et al. Attributable deaths and disability-adjusted life-years caused by infections with antibiotic-resistant bacteria in the EU and the European Economic Area in 2015: a population-level modelling analysis. The Lancet Infectious diseases. Volume 19, Issue 1, January 2019, Pages 56-66. // https://doi.org/10.1016/S1473-3099(18)30605-4

Epidemics and pandemics receive considerable attention in national risk assessments. Twenty-three countries included this risk in their latest reports. The most common scenario analysed is pandemic influenza. An influenza pandemic is widely seen as a medium to high likelihood event with a high impact. The timeframe within which countries expect the next pandemic to occur varies significantly, from once in the next 5 years to once in the next 100 years.

Compared to the previous editions of national risk assessments, the range of infectious diseases covered is broader and includes new, re-emerging (e.g. measles, diphtheria) and food/water-borne diseases. More attention is being paid to risk drivers, such as decreasing vaccination rates or the contribution of climate change and international travel to the spread of pathogens.

Besides the epidemic scenarios, two other related health issues are receiving increased attention: antimicrobial resistance and the risk of a disruption in the supply of pharmaceuticals. Regarding the supply of medicines, a main concern is global dependence on a few producers – a dangerous situation should a pandemic break out. This even led to one country identifying this risk as one of its top national risks.

6.5. Addressing the risk: EU actions

Communicable diseases and other health threats caused by biological, chemical or environmental agents can easily spread across national borders. This is why the EU coordinates, supports and complements actions taken in this area by Member States. The legal framework is set out in Decision 1082/2013/EU on serious cross-border threats to health[436]. It supports EU countries in preparing for and protecting people against possible future pandemics and other serious cross-border threats by:

- improving coordination and information sharing on national preparedness;
- improving surveillance and risk assessment;
- providing the basis for a joint procurement of medical countermeasures such as vaccines or antivirals;
- stepping up the early warning and coordination of an EU-wide response to health crisis through the Health Security Committee[437]; and
- strengthening the coordination of risk and crisis communication, and fostering international cooperation.

The European Centre for Disease Prevention and Control (ECDC) plays an important role at EU level in monitoring and assessing current and emerging threats from infectious diseases. ECDC activities help strengthen the EU's preparedness and response thanks to epidemic intelligence, rapid risk assessments, simulation exercises, after action reviews and capacity-building actions.

The Early Warning and Response System (EWRS), which facilitates the monitoring and response activities, is used by the EU and Member States for notifications on outbreaks, exchanging information and decisions about the coordination of measures. Over the years, the EWRS has proven its value in dealing with health crises, such as those related to SARS, the Ebola virus disease, avian influenza in humans and other communicable diseases.

In the event of a public health crisis that challenges national response capacities, Member States can ask for assistance through the UCPM. One of the UCPM's key assets is the European Medical Corps. It brings together medical teams and equipment that can be deployed to deal with any type of emergency with health consequences, within or outside the EU. Public health teams can assist in assessing the situation and needs, analyse public health risks, advise on response measures or carry out specific tasks (e.g. vaccination). The collective preparedness for future health crises in the EU has been boosted thanks to the development of rescEU – a new reserve of European response capacities. Capacities for medical emergencies have been identified as one of the priorities for the rescEU pool. The relevance and need for such capacities became apparent during the COVID-19 pandemic which

[436] Decision No 1082/2013/EU of the European Parliament and of the Council of 22 October 2013 on serious cross-border threats to health and repealing Decision No 2119/98/EC (Text with EEA relevance).

[437] Health Security Committee, available at https://ec.europa.eu/health/preparedness_response/risk_management/hsc/members_en

accelerated the establishment of the rescEU stockpile of medical equipment.

Besides the EU's crisis preparedness and management arrangements described above, several policy and legislative instruments target specific issues. Regarding vaccine-preventable diseases, a range of new initiatives have been put forward at EU level over recent years. In 2018, there was the publication of the Commission Communication[438] and the Council Recommendation[439] on strengthened cooperation against vaccine-preventable diseases. These documents provide the political framework for strengthened cooperation at EU level in the area of vaccination, focusing on vaccine hesitancy, sustainability of national vaccination programmes and vaccination coverage. The same year, a Joint Action on Vaccination was launched to develop tools to support national authorities in responding to common vaccination challenges. In 2019, a Coalition for Vaccination was convened, bringing together European associations of healthcare workers and relevant students' associations in the field. The Coalition will help to provide accurate information to the public, combat myths around vaccines and vaccination, and enable the exchange of best practices on vaccination. In order to step up the preparedness for a pandemic influenza scenario, the Commission and Member States cooperated in purchasing the vaccines through the joint procurement mechanism (*Box 21*).

Box 21. Stepping up European preparedness for a pandemic influenza: joint procurement of vaccines

In spring 2019, 15 Member States and the Commission signed framework contracts for the production and supply of pandemic influenza vaccines under the joint procurement mechanism. By pooling needs and increasing volumes to be purchased, the agreement i) improves national preparedness for the next flu pandemic, ii) ensures equal treatment, iii) guarantees more balanced prices and iv) shows solidarity between EU Member States that agree to share a limited availability of flu vaccines in the event of a pandemic. For the future, EU Member States have expressed interest in the joint procurement of medical countermeasures against tuberculosis and diphtheria.

As regards antimicrobial resistance, EU actions for addressing the phenomenon are outlined in the European One Health action plan[440], adopted in 2017. The action plan approaches this health threat in a holistic and multidisciplinary manner, setting out measures to be implemented across different sectors, such as human and animal health, agriculture, the environment and research. An important milestone was achieved in 2019, when new European legislation on veterinary medicines and medicated feed was adopted[441]. New rules prohibit, as of 2022, the preventive use of antimicrobials for animals or to promote their growth, and certain antimicrobials may be reserved for human use only. These restrictions will also apply to non-EU countries that export to the EU.

To protect consumers from foodborne diseases, the EU follows an integrated approach to food safety known as 'from farm to fork'. EU food hygiene legislation sets out requirements for food producers and operators and provides rules for checks. EU legislation also regulates the monitoring and control of foodborne diseases. The European Food Safety Authority provides scientific advice on existing and emerging risks associated with the food chain.

Further reducing the risk associated with communicable diseases requires progress in: i) prevention, ii) surveillance, iii) detection and early warning, iv) development, production and stockpiling of vaccines and treatments, v) clinical management, vi) awareness-raising, vii) training, viii) strengthening health systems to improve resilience and many other processes.

[438] COM(2018) 245/2.

[439] Council Recommendation of 7 December 2018 on strengthened cooperation against vaccine-preventable diseases – 2018/C 466/01. Available at http://data.consilium.europa.eu/doc/document/ST-14152-2018-REV-1/en/pdf

[440] COM(2017)0339

[441] Regulation (EU) 2019/6 of the European Parliament and of the Council of 11 December 2018 on veterinary medicinal products and repealing Directive 2001/82/EC; and

Regulation (EU) 2019/4 of the European Parliament and of the Council of 11 December 2018 on the manufacture, placing on the market and use of medicated feed, amending Regulation (EC) No 183/2005 of the European Parliament and of the Council and repealing Council Directive 90/167/EEC.

Under Decision 1082/2013/EU on serious cross-border threats to health[442], EU Member States provide information on the state of preparedness and response planning at national level every 3 years. This allows for gaps and needs to be identified regularly. Ongoing information exchange and consultation with the Member States through the Health Security Committee, as well as capacity-building exercises, training and workshops allow the Commission and Member States to improve preparedness and coordinate responses to health threats at EU level.

Joint Actions by Member States under the EU health programme are helping with: i) the exchange and implementation of good practices, ii) the preparedness at points of entry, iii) the implementation of the core capacities of international health regulations, as well as iv) the preparedness for biological and chemical terrorist attacks.

Several EU financial instruments provide support for cooperation, capacity-building and research activities in the fight against serious cross-border health threats. These include the EU health programme mentioned above, the innovative medicine initiative and Horizon 2020. Looking forward, in the EU multiannual financial framework 2021-2027, the Commission has proposed a new EU health programme – EU4Health – with the budget of EUR 9.4 billion to:

- strengthen crisis preparedness and response to cross-border health threats, in line with, where relevant, the One Health approach;
- strengthen health systems, their resilience to crises, and their capacity to promote health and prevent diseases;
- improve the availability of medicines and other products relevant to addressing crises;
- support integrated work among Member States and national health systems.

Research and innovation play a crucial role in improving health security. By September 2020, the EU has invested EUR 459 million from Horizon 2020 in grants for 103 research projects targeting the COVID-19 pandemic. These projects focus on diagnostics, treatment, vaccines, epidemiology, preparedness and response to outbreaks, behaviour and socioeconomics, manufacturing, medical and digital technologies, as well as the infrastructure and data resources that enable this research. The Commission and Member States have also agreed on the first ERAvsCorona action plan[443] which lays out 10 short-term priority coordinated actions to tackle coronavirus. The new Horizon Europe research programme for 2021-2027 will have a specific cluster on health, as well as links with other clusters to fund ground-breaking research into all aspects of preparedness for serious cross-border health threats.

7. Animal and plant diseases

7.1. The risk and trends

Animals and food production can be exposed to a variety of serious infectious diseases. Some animal diseases are confined to a single species, while others can spread from one species to another. A distinction is made between epizootic diseases which cannot be transmitted to humans (e.g. foot-and-mouth disease) and zoonotic diseases which can be transmitted naturally from animals to humans (e.g. avian influenza).

Since some animal-borne diseases can be transmitted to humans and because of food safety concerns, animal diseases are considered to be a major threat to public health. Besides human and animal health implications, disease outbreaks can have many other negative effects, such as i) costs to livestock farmers and related industries, ii) business disruption, iii) loss of markets, iv) potential changes in consumption patterns, and v) high public sector costs related to disease eradication and monitoring action. Highly transmissible animal diseases easily spread across borders and can lead to an international emergency. Countries with an industrialised agricultural sector are highly vulnerable to the spread of diseases. Many animal diseases affect wildlife and may have a negative impact on the environment (e.g. biodiversity loss). Infected

[442] Decision No 1082/2013/EU of the European Parliament and of the Council of 22 October 2013 on serious cross-border threats to health and repealing Decision No 2119/98/EC (Text with EEA relevance).

[443] First "ERAvsCORONA" Action Plan. – 7 April 2020 – Available at https://ec.europa.eu/info/files/first-eravscorona-action-plan-short-term-coordinated-research-and-innovation-actions_en

wildlife, in turn, can play a role in the recurrence of outbreaks and in transmitting pathogens to both domestic animals and human beings.

The type and incidence rate of infectious animal diseases vary across the EU, depending on climate conditions, farm types and management, veterinary and agricultural practices, and animal movements. The unpredictable occurrence and behaviour of animal disease epidemics makes forecasting their frequency and impact difficult[444]. The most severe epidemic livestock diseases requiring priority attention across the EU are listed in the relevant EU legislation[445]. Based on current levels of veterinary preparedness, the greatest risks for the EU are presented by: i) the classical and African swine fever (viral infections affecting porcine animals), ii) foot-and-mouth disease (a highly-contagious viral infection affecting ruminants and pigs), iii) avian influenza (a viral infection affecting birds - *Box 22*), iv) lumpy skin disease (a viral disease affecting cattle), v) peste des petits ruminants (a viral disease affecting goats and sheep) and vi) sheep and goat pox.

Box 22. Outbreaks of animal diseases in the EU: the 'bird flu'

In 2016-2017, European poultry farms were hit by an epidemic of a highly pathogenic avian influenza. The epidemic was the largest ever recorded in the EU in terms of number of poultry outbreaks, geographical extent and number of dead wild birds[446]. Between October 2016 and November 2017, there were several thousand outbreaks in 25 EU Member States, affecting millions of birds[447].

Avian influenza virus is primarily a bird disease, but elsewhere in the world there have been cases of affected humans who came into close contact with infected birds. Therefore, the disease is a threat not only to poultry production, but also to public health. While in the 2016-2017 epidemic, no transmission to humans occurred, the general concern is that avian influenza viruses have the potential to mutate into a strain which could be transmitted to humans, and subsequently between humans. This in turn could lead to a human influenza pandemic.

Besides animal diseases, Europe's agricultural, forestry and food production sectors are also under threat from pests and diseases that attack agricultural crops, trees and other plant species. They could potentially eradicate crops and could result in food security risks and nutrition crises. Recently, 20 quarantine pests were identified as priority pests[448] requiring increased action from public authorities due to the severity of economic, social and environmental impacts they can cause. Some prime examples are Moroccan and Italian locusts, the Grapevine Flavescence Dorée (affecting vine plants), the Xylella fastidiosa (affecting olive trees - *Box 23*), the pinewood nemathode (Portugal), and the bark beetle (Germany, Czechia and Slovakia); these are all capable of extreme levels of breeding on a regional scale.

444 SWD(2013) 161 final.

445 Article 5(1) of Regulation (EU) 2016/429 of 9 March 2016 on transmissible animal diseases and amending and repealing certain acts in the area of animal health ('Animal Health Law'), OJ L 84, 31.3.2016, p.1. Diseases categorised as 'A diseases' in Implementing Regulation (EU) 2018/1882.

446 European Food Safety Authority. Avian influenza. Available at https://www.efsa.europa.eu/en/topics/topic/avian-influenza

447 EFSA (European Food Safety Authority), ECDC (European Centre for Disease Prevention and Control), EURL (European Reference Laboratory on Avian Influenza), Brown I, Kuiken T, Mulatti P, Smietanka K, Staubach C, Stroud D, Therkildsen OR, Willeberg P, Baldinelli F, Verdonck F and Adlhoch C, 2017. Scientific report: Avian influenza overview September – November 2017. EFSA Journal 2017;15(12):5141, 70 pp. doi:10.2903/j.efsa.2017.5141.

448 Commission Delegated Regulation (EU) 2019/1702 of 1 August 2019 supplementing Regulation (EU) 2016/2031 of the European Parliament and of the Council by establishing the list of priority pests.

Box 23. Outbreaks of plant diseases in the EU: *Xylella fastidiosa*

The bacterium *Xylella fastidiosa* affects olive trees, almond trees and grapevines among other agricultural crops and is one of the most harmful plant bacteria in terms of economic, social and environmental impacts. In Europe, it was first detected in Italy in 2013 and by 2017 it had severely damaged some 6.5 million olive trees in the area. The disease has spread to France, Spain and Germany. Control measures can contain the disease, but there is still no known way to eradicate it from a sick plant. Though southern Europe is the most exposed to the bacterium, research suggests that *Xylella* has the potential to spread across the entire EU. The JRC has estimated that in this worst-case scenario, *Xylella fastidiosa* could cost the EU over EUR 5.5 billion per year due to loss of production, with potential export losses of EUR 0.7 billion per year. This could also put at risk nearly 300 000 jobs in the production of olives, citrus fruits, almonds and grapes.

Source: JRC[449]

7.2. Key risk drivers

There are many factors behind the entry, establishment and spread of animal and plant diseases in a region. The key drivers include globalisation, climate change, and changes in land management and agricultural practices. The increase in movement of people, animals, plants and products has accelerated the redistribution of pathogens and diseases. In addition, changes in climate are altering geographical and temporal distribution of pests, weeds, parasites and diseases. For example, there is evidence that midges – vectors of bluetongue disease – advanced from Africa into southern Europe because of increased humidity and temperature. The movement of blood-feeding flies, mosquitoes and ticks is responsible for the spread of lumpy skin disease from the Middle East to southeast Europe[450].

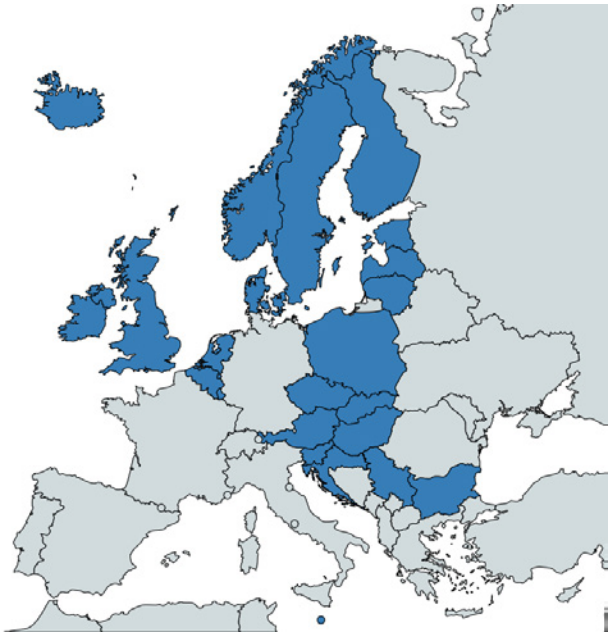
Box 24. Climate change and emerging risks for food and feed safety, plant, animal health and nutritional quality

In 2018, the European Food Safety Authority launched a project on 'Climate change as a driver of emerging risks for food and feed safety, plant, animal health and nutritional quality' (CLEFSA). The project aims to develop methods and tools to identify and define emerging risks related to climate change. The outcomes will be published in 2020.

[449] Plant Health: prioritising the fight against 20 quarantine plant pests on the EU territory. Available at https://ec.europa.eu/jrc/en/news/how-big-are-potential-impacts-quarantine-pests-eu-agriculture-and-forestry

[450] The European Food Safety Authority. Climate change and food safety. Available at https://www.efsa.europa.eu/en/topics/topic/climate-change-and-food-safety

7.3. Animal and plant diseases in national risk assessments



Epizootic/plant disease risk in NRAs 2015

Epizootic/plant disease risk in NRAs 2018/2019

Approximately two thirds of countries identify infectious animal or plant diseases or both as national disaster risks. Compared to previous editions of national risk assessments, two countries added these risks in their reports for the first time. Most commonly discussed animal diseases include the classical and African swine fever, the foot-and-mouth disease and avian influenza. Plant diseases considered in national reports include pests and diseases affecting vines, potatoes and trees, such as i) golden vine jaundice, ii) potato wart, iii) brown potato rot, iv) Agrilus anxius pest, v) the pine wood nematode and the vi) bark beetle which has reduced the forest tree species and has had a huge impact on forest production, products and services.

Plant diseases can also result from the international trade of plants and forest timber as well as from forest fires and the subsequent ecosystem's degradation. Additionally, there are cascading effects from the outbreaks of plant diseases reported in the national risk assessments that include impacts on arable crops due to contamination, availability of seeds and seedlings and reduced quality standards of agricultural and forest timber products.

Regarding the level of risk associated with animal and plant epidemics, the assessment varies extensively, depending on the country and scenario/disease considered. Overall, the reports emphasise that infectious animal diseases may cause significant financial burden and risks to public health and food security. Besides immediate losses and costs of managing the outbreak, there are also longer-term consequences, such as undermined confidence in the markets, disruption of export activities and possibly job losses. The reports tend to underline that diseases can easily spread across borders between countries.

While national risk assessments note that there are rigorous prevention and control measures in place to manage the risk of animal and plant diseases, the likelihood of future outbreaks is seen to be increasing due to climate change and international trade.

7.4. Addressing the risk: EU actions

EU legislation sets out a range of measures aimed at preventing and controlling the spread of major diseases that can have significant economic and health impacts at EU level. The approach to controlling animal diseases is based on several aspects, namely:

- specific control measures in place for each disease[451], addressing its unique epidemiological profile and consequences;
- surveillance;
- the notification system;
- EU financial support;
- the EU emergency team;
- the traceability system;
- the EU reference laboratories for selected diseases; and
- EU stockpiles of emergency vaccinations.

The EU has specific legislation for a number of animal diseases depending on their potential social and economic impact. Provisions cover issues such as notification obligations, diagnostic methods, measures to be applied in case of suspicion and confirmation of disease and, where applicable, regionalisation measures[452].

- Avian influenza is covered under Directive 2005/94/EC[453]. To limit the spread of the disease, the Directive requires suspected cases of avian flu to be investigated, infected poultry to be humanely killed, and feeding stuffs/equipment/manure to be disposed of.
- Classical swine fever is covered under Directive 2001/89/EC[454] and African swine fever under Directive 2002/60/EC[455]. In the event of an outbreak, all pigs on infected farms must be put down and cadavers destroyed, and protection and surveillance zones must be put in place. Regarding classical swine fever, provisions are made for emergency vaccination and the EU has stocks of vaccines for this purpose.
- Measures to combat African Horse Sickness are laid out in Directive 92/35/EEC.
- EU control measures for foot-and-mouth disease are laid out in Directive 2003/85/EC[456], which aims to help the territory in question regain its disease infection-free status In the case of foot-and-mouth disease, provisions are also made for the use of emergency vaccinations. As a result, the EU has stocks of antigens for express vaccine formulations.

For certain animal diseases, vaccination is of key importance in the event of an outbreak. In light of this, the EU established a system of vaccine banks which complements the national approaches by making vaccines immediately available to Member States and neighbouring third countries in case of emergency situations.

New EU legislation to control transmissible animal diseases – the Animal Health Law[457] – was adopted in 2016 and will be applied as of 21 April 2021. The Animal Health Law streamlines a large number of legal acts into a single comprehensive regulatory framework.

[451] Directive 2005/94/EC of 20 December 2005 on Community measures for the control of avian influenza and repealing Directive 92/40/EEC; Directive 2001/89/EC of 23 October 2001 on Community measures for the control of classical swine fever; Council Directive 2002/60/EC of 27 June 2002 laying down specific provisions for the control of African swine fever and amending Directive 92/119/EEC as regards Teschen disease and African swine fever; Directive 2003/85/EC of 29 September 2003 on Community measures for the control of foot-and-mouth disease repealing Directive 85/511/EEC and Decisions 89/531/EEC and 91/665/EEC and amending Directive 92/46/EEC.

[452] Regionalisation is a tool used to control diseases and/or maintain safe trade by restricting trade from areas affected by disease, whilst avoiding trade disruptions in goods from unaffected areas.

[453] OJ L 10, 14.1.2006, p. 16.

[454] OJ L 316, 1.12.2001, p. 5.

[455] OJ L 192, 20.7.2002, p. 27.

[456] OJ L 306, 22.11.2003, p.1.

[457] Regulation (EU) 2016/429 of the European Parliament and of the Council of 9 March 2016 on transmissible animal diseases and amending and repealing certain acts in the area of animal health ('Animal Health Law').

As regards plant diseases, the new EU 'Plant Health Law'[458] applies from December 2019. The new rules aim at boosting the effectiveness of measures taken to protect plants. They also aim to ensure safe trade, as well as mitigate the impacts of climate change on the health of agricultural crops and forests. Among the measures included in this legislation is the list of the most dangerous pests. For each of the listed pests, EU Member States are required to i) carry out annual surveys, ii) draw up and keep up to date a contingency plan, iii) carry out simulation exercises, iv) communicate with the public, and v) adopt an eradication plan. All these actions contribute to the EUs' coordinated, harmonised preparedness strategy for protecting agriculture, forests, the environment and the economy from dangerous pests.

The EU has a notification system where Member States are required to notify the Commission of an outbreak as well as its eradication for certain contagious diseases, so as to prevent their spread in the EU.

Each year, the EU finances Member States' programmes to eradicate, control, and monitor certain animal diseases. In times of crisis, EU funds are available to co-fund emergency measures aiming at quickly eradicating and preventing the spread of animal disease.

8. Nuclear and radiological accidents

8.1. The risk and trends

Nuclear accidents are critical events involving nuclear facilities or activities which can lead to the release of radioactive material and which may also have transboundary implications[459]. These facilities include nuclear power plants, but also installations handling nuclear material (e.g. nuclear fuel re-processing plants), storage facilities for used nuclear fuel, nuclear-powered vessels, and research facilities. Radiological accidents can also take place while radioactive material is being transported as well as during other activities involving industrial, research or medical radiation sources.

Nuclear power reactors are the most common nuclear facility. There are currently 124 nuclear power reactors in operation in the EU[460], grouped on 55 sites in 14 Member States[461] (*Figure 50*). Their safety record is such that although incidents have occurred, the engineered safety systems designed with significant redundancy[462] to prevent escalation of incidents have ensured that no major accidents have ever taken place[463].

[458] Regulation (EU) 2016/2031 of the European Parliament of the Council of 26 October 2016 on protective measures against pests of plants, amending Regulations (EU) No 228/2013, (EU) No 652/2014 and (EU) No 1143/2014 of the European Parliament and of the Council and repealing Council Directives 69/464/EEC, 74/647/EEC, 93/85/EEC, 98/57/EC, 2000/29/EC, 2006/91/EC and 2007/33/EC.

[459] International Atomic Energy Agency (IAEA) Safety Glossary. Available at https://kos.iaea.org/iaea-safety-glossary/97.html

[460] Situation at the end of 2019.

[461] Belgium, Bulgaria, Czech Republic, Germany, Spain, France, Hungary, the Netherlands, Romania, Slovenia, Slovakia, Finland, Sweden and the United Kingdom.

[462] Redundancy is the duplication of critical components or functions of a system with the intention of increasing reliability of the system, usually in the form of a backup.

[463] Terminology on incidents and accidents according to the categorisations of the International Nuclear Event Scale of the IAEA. Available at: http://www.iaea.org/Publications/Factsheets/English/ines.pdf

Blue – operational; *Green* – shutdown or in decommissioning; *Orange* – in construction; *Brown* – planned.

Figure 50. Nuclear reactors in Europe. Source – JRC.

In general, there is an extremely low probability of nuclear accidents occurring, but when they do, they have a high impact. Due to the potentially high human, economic and environmental impact of a severe nuclear accident, nuclear power plants are subject to strict safety and security checks and strict prevention and mitigation measures are in place.

Climate change and more frequent extreme natural events could potentially lead to an increased risk of accidents in nuclear power plants or facilities containing radioactive substances. However, this is considered in safety assessments, taking account of their projected lifetimes[464].

[464] WENRA (Western European Nuclear Regulators Association). Guidance Document Issue T: Natural Hazards. Head Document. – 21 April 2015. Available at http://www.wenra.org/media/filer_public/2015/04/23/wenra-rhwg_t1_guidance_on_issue_t_head_document_2015-04-21.pdf

8.2. Nuclear/radiological accidents in national risk assessments

Nuclear/radiological risk in NRAs 2015

Nuclear/radiological risk in NRAs 2018/2019

The risk of nuclear and radiological accidents receives considerable attention in national disaster risk assessments. Twenty-five countries covered this risk in their latest reports. Two of them included the risk for the first time in their reporting under the EU civil protection legislation.

All countries with nuclear reactors on their territories assess the risk of a nuclear accident. Furthermore, a number of countries with no domestic nuclear installations also assess the risk, taking into account potential incidents abroad: across the border and/or on the continent. Besides accidents in nuclear power plants, other scenarios analysed include i) emergencies involving research reactors, ii) nuclear fuel cycle facilities, iii) nuclear-powered vessels in national waters and iv) multiple incidents with radiological substances.

The potential causes of nuclear and radiological accidents that have been considered range from technical failures and human errors to the cascading effects of other disasters, such as earthquakes, floods or plane crashes. Some national risk assessments also include disasters caused by deliberate unlawful activities, while others limit the scope to technological accidents without malicious intent.

Nuclear accidents are predominantly seen as a low-likelihood risk, largely owing to the high level of safety arrangements in place. A number of risk assessments mention that the nuclear stress tests carried out in Europe after the Fukushima disaster and the follow-up actions undertaken based on their results have further increased the level of safety of EU nuclear installations. Some reports also make reference to the recent transposition of the revised Euratom 'Basic Safety Standards Directive'[465] which strengthened the requirements on emergency preparedness and response.

Despite their low likelihood, nuclear accidents could still occur, with potentially serious consequences. The impact would depend on a number of factors, such as i) the location of the accident, ii) the type and quantity of radioactive materials involved, iii) weather conditions and iv) the capacity to deal with the emergency. In the event of significant amounts of radioactive material being released, the atmosphere, soil, water and agricultural products could be contaminated. There is an increased risk of short and/or long-term health effects as a result of external or internal (e.g. through contaminated food products or drinking water) exposure to high doses of ionising radiation.

[465] Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom.

Economic costs could add up to billions of euros due to losses in the agricultural sector, tourism and industrial production. Part of the affected territory might become uninhabitable for a long period of time. Costs for clean-up and recovery actions could also be significant. The cross-border dimension of nuclear accident risk is prominent in national assessments: a serious nuclear accident would affect several countries simultaneously and would likely require international cooperation in order to respond to it.

Regarding radiological accidents, their estimated likelihood varies greatly across national risk assessments, from very unlikely to very likely. Overall, the impact of these events is seen as more localised compared to nuclear accidents.

Several national risk assessments reflect on the future trends in nuclear risk, taking into consideration broader developments in energy and climate policies. Some countries in Europe have decided to phase out nuclear energy. Others are building new power plants. New technological solutions are emerging with a promise of safer and more efficient nuclear reactors. The role of nuclear power is being revisited in the context of strategies aimed at reducing greenhouse gas emissions and fighting climate change. In view of the latter, one report draws attention to the fact that operations in nuclear power plants will need to be adapted to changes in climate. This is because climate change may lead to a reduction in available cooling water as well as higher risks stemming from extreme weather events. While the outcomes of these developments are not easy to predict, it is recognised that they will influence the nuclear safety landscape in Europe for years to come.

8.3. Addressing the risk: EU actions

EU policies deal with nuclear activities from three angles.

- Nuclear safety: the safe operation of nuclear installations. It is complemented by radiation protection and radioactive waste management.
- Nuclear safeguards: measures to ensure that nuclear materials are used only for the purposes declared by users.
- Nuclear security: the physical protection of nuclear material and installations against intentional malicious acts.

The EU promotes the highest safety standards for all types of civilian nuclear activity, including power generation, research, and medical use. Following the Fukushima nuclear accident, a comprehensive risk and safety assessment (stress test) of all EU nuclear power plants was carried out to assess the safety and robustness of nuclear installations in the event of extreme natural events. While the assessments found that the safety standards of nuclear power plants in EU were generally high, the review highlighted the need for further upgrades and put forward a range of recommendations for improvement[466] [467]. The recommendations had to be implemented by plant operators, under the supervision of national authorities. National action plans developed in 2012 have been regularly updated and reviewed, most recently in 2019, by the European Nuclear Safety Regulators Group (ENSREG).

Taking into account some of the lessons learned from the Fukushima accident and the stress tests exercise, the Council Directive establishing a community framework for the safety of nuclear installations was amended in 2014[468]. The revised legislation added a new safety objective to prevent and mitigate accidents, and new provisions on topical peer reviews, and on-site emergency preparedness and response. The revised Euratom 'Basic Safety Standards Directive'[469] strengthens the requirements on emergency preparedness and response complementing the revised Nuclear Safety Directive. Both Directives are being implemented by Member States.

Due to the age profile of the European nuclear reactor fleet and considering the potential long-term operation of European nuclear power plants, ENSREG identified the 'ageing management' of nuclear power plants and

[466] COM(2012) 571 final.

[467] SWD(2012) 287.

[468] Directive 2014/87/Euratom of 8 July 2014 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations, 25.7.2014, OJ L 219, pp. 42-52.

[469] Council Directive 2013/59/EURATOM of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom.

research reactors as the topic for the first topical peer review which took place in 2017-2018. In response to the findings, participating countries have produced national action plans whose implementation will be followed by ENSREG.

The cross-border dimension of nuclear accidents calls for strong cooperation between the EU Member States as well as with non-EU countries on i) safety assessments of nuclear power plants, ii) early warning, iii) sharing assessments of the exposure, iv) coordinating protective measures and public information, and v) training and exercises. A number of emergency arrangements exist at EU level and beyond, providing networks that integrate national monitoring systems and allow for rapid, coordinated responses to radiological emergencies by sharing real-time data on an urgent basis (e.g. ECURIE and EURDEP)[470]. Through the European Community Urgent Radiological Information Exchange System (ECURIE)[471], a Member State deciding to take measures of a widespread nature to protect the general public in the event of a radiological emergency, must immediately notify the European Commission and those Member States which are, or are likely to be affected. Via the European Radiological Data Exchange Platform (EURDEP), monitoring data are continuously and automatically exchanged with 38 countries and are made available to the national authorities responsible for dealing with radiological/nuclear emergencies, as well as to the general public[472].

Safety improvements for the mitigation/elimination of the consequences of accidents at nuclear installations, as well as actions in the field of emergency preparedness and radiation protection are also carried out under the 'Euratom Research and Training Programme'. The calls for proposals are managed by the Directorate-General for Research and Innovation of the European Commission.[473]

9. Disruption of critical infrastructure

9.1. The risk and trends

Critical infrastructures are complex interconnected systems that are subject to a wide range of hazards and threats. Man-made threats include terrorism, cyberattacks and sabotage by internal (insider) or external perpetrators. Accidental risks include technical breakdowns, air, rail or road accidents, and fires and explosions. Natural hazards include storms, floods, or epidemics/pandemics. In this time of rapid climate change and intensifying natural disasters, infrastructure systems are under pressure to deliver resilient and reliable services.

The disruption of critical infrastructure can affect the delivery of essential services, including the provision of energy, transport, water, food, communications, health, emergency response services, payments/financial operations. The final impacts depend on the duration of the disruption, the time of year, the resilience of the service and the response by the authorities. They may involve human casualties, severe social effects and negative economic consequences.

As interdependencies increase, the potential for systemic failures is increasing. With the increased interdependence of essential services, the failure of one critical infrastructure may trigger cascading effects, disrupting the operation of other key services. The increasing complexity, interdependency and scale of infrastructure networks can make them more difficult to protect. While technological developments have improved the quality of essential services, this progress itself creates new vulnerabilities. The growing challenges associated with understanding and protecting complex, interdependent infrastructure networks mean that the resilience of critical infrastructure networks – their ability to recover from incidents – is becoming ever more important.

[470] ENSREG – Emergency arrangements at EU level. Available at http://www.ensreg.eu/nuclear-safety/preventionaccidents/Emergency-arrangements-at-EU-level

[471] Council Decision 87/600 on Community arrangements for the early exchange of information in the event of a radiological emergency.

[472] https://remap.jrc.ec.europa.eu/Advanced.aspx

[473] Commission Implementing Decision C(2018) 8412 of 14 December 2018 on the financing of indirect actions within the framework of Council Regulation (Euratom) No 2018/1563 and on the adoption of the work programme for 2019-2020. – Available at https://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/euratom/h2020-wp1920-euratom_en.pdf

9.2. Key risk drivers

The risks to critical infrastructures may increase in the future as new threats emerge. Climate change is expected to heavily affect infrastructure through heatwaves, floods and droughts[474]. Due to climate change alone, annual damage to Europe's critical infrastructure could increase ten-fold by the end of the century under business-as-usual scenarios, from the current EUR 3.4 billion to EUR 34 billion[475]. The highest losses would be borne by the industry, transport and energy sectors. Southern and south-eastern European countries will be most affected. Energy black-outs, due to the vulnerabilities of critical infrastructure networks, affect all sectors of European societies, with immediate negative effects on populations and economies.

The unlawful use of drones is an emerging threat, as demonstrated in December 2018 by the disruption to air traffic at the Gatwick airport in the UK. The overall increase in the terrorist threat in the EU also applies to the critical infrastructure environment. Individuals or groups with malevolent intent might seek to attack critical infrastructure networks as a part of a broader hybrid influencing strategy that might combine physical attacks and cyberattacks with disinformation campaigns. The operation and security of critical infrastructure may also be affected by changing ownership structures or by the deployment of foreign-sourced components.

The landscape of critical infrastructure protection is rapidly evolving. In the coming years, the discussion will probably be more about critical infrastructure systems, even systems of systems, and their interaction. Another expected trend is a shift in focus from protection to resilience, reflecting an increase in the number of threats and their complexity, such that threats cannot always be predicted and incorporated in a pure risk management approach[476].

9.3. Disruption of critical infrastructure in national risk assessments

Critical infrastructure disruption risk in NRAs 2015

Critical infrastructure disruption risk in NRAs 2018/2019

[474] Forzieri G., Bianchi A., Marin Herrera M. A., Batista e Silva F., Feyen L. and Lavalle C. Resilience of large investments and critical infrastructures in Europe to climate change. JRC Technical report, 2015 - Publications Office of the European Union. ISBN: 978-92-79-54003-5 DOI: 10.2788/171858.

[475] .The study 'Escalating impacts of climate extremes on critical infrastructures in Europe' shows that expected financial damage to critical infrastructure caused by climate-related hazards in Europe are expected to grow to approximately EUR 9.3 billion by the 2020s, EUR 19.6 billion by the 2050s and EUR 37.0 billion by the 2080s, only as a result of the effects of climate change. Currently, the expected annual damage is EUR 3.4 billion per year for EU+ (EU28 plus Switzerland, Norway, and Iceland): https://ec.europa.eu/jrc/en/news/critical-infrastructure-be-hard-hit-climate-hazards

[476] Bordin, G., Hristova, M., Luque-Perez, E. (eds.), Security and Defence Research in the European Union: A landscape review — Executive summary, EUR 29864 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-11591-5, doi:10.2760/388606, JRC117742.

Disruption of critical infrastructure[477] is a complex theme, with different approaches used across the national risk assessments to address the issue. As a rule, it is considered among the impacts stemming from other risks: for example, power outage due to an earthquake or cyberattack. In this case, the implications and cascading effects of the disruption itself are usually not examined in detail. In contrast, several national reports focus on critical infrastructure disruption as a theme in its own right, focusing on the impacts and knock-on effects a failure might trigger, irrespective of the event causing it. In the latest cycle, one country even took the protection of vital societal functions as a point of departure and organised the entire risk assessment around them, rather than around individual hazards or threats. Lastly, many national submissions assess events that are not specifically labelled as critical infrastructure disruptions, but which could be discussed under this heading. For example, national reports assess the risk of transport accidents, disruptions in the supply of energy, water, food and pharmaceuticals, ICT and satellite services or financial services. Among those, incidents in the transport and energy sectors receive the most attention.

While a large-scale disruption to electricity supply remains a predominant concern in national risk assessments, failures in other supply systems have been receiving increasing attention. When compared to the previous assessment round, there has been a growing unease about the security of supply in some areas of Europe, especially when seen in the context of climate change and developments in the security landscape. The changing geopolitical scene may have consequences for the supply of fuels. The increased frequency of extreme weather events might jeopardise the supply of food and drinking water. The structure of the global pharmaceutical market means there is a risky dependence on a few producers. New threats, such as hybrid attacks on critical infrastructure, emerge as a new theme in several national risk assessments.

As threats to critical infrastructure are increasing, national risk assessments recognise that vulnerabilities are also increasing. Our societies are dependent on the uninterrupted provision of critical services. Technological innovations (internet of things, 'smart' technologies), networking and automation of processes are increasing the interconnectedness between physical and digital systems. Critical infrastructure is becoming more interconnected across sectors and beyond national borders. As a result, the failure or manipulation of critical infrastructure can have far-reaching consequences.

There are examples of national submissions that seek to map relationships between critical processes and explore vulnerabilities, dependencies and impacts through a set of scenarios. However, it remains a challenge to address this complexity in national risk assessments. While cross-sectoral interdependencies are tackled to some extent, the cross-border/regional/international dimension for the most part remains outside the scope of national submissions.

Several submissions refer to the ongoing work aimed at improving the knowledge and security of critical infrastructure. These include reviewing the 'criticality' of infrastructure on the basis of uniform criteria and dedicated risk analyses. The areas requiring further work include the following: i) a coordinated approach to protecting critical infrastructure, ii) public awareness of and preparedness for the failure of critical processes, iii) agreements on allocating emergency supplies in the event of a large-scale disruption, and iv) the physical security of critical objects.

9.4. Addressing the risk: EU actions

The European programme for critical infrastructure protection (EPCIP), based on an all-hazards approach, sets out the overall policy approach and framework for activities that protect critical infrastructure in the EU. It is based on an all-hazards approach. A key aspect of the EPCIP is Directive No. 2008/114/EC on identifying and designating European critical infrastructures[478], which aims to step up the protection of critical infrastructure in the EU's energy and transport sectors, the disruption or destruction of which would have significant cross-border impacts. The Directive achieves this by setting out a procedure for

[477] Council Directive 2008/114/EC defines critical infrastructure as 'an asset, system or part thereof located in Member States which is essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people, and the disruption or destruction of which would have a significant impact in a Member State as a result of the failure to maintain those functions.'

[478] Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection (Text with EEA relevance), OJ L 345, 23.12.2008, p. 75–82.

identifying and designating European critical infrastructures and a common approach to assessing the need for improving their protection.

The 2019 external evaluation of the Directive's implementation[479] concluded that having a common approach to protecting European critical infrastructure added value at an EU level and that the Directive had raised awareness of this issue at the national level. At the same time, the report also found that the Directive, adopted in 2008, had 'aged' and was no longer fit to address the significantly changed security landscape.

In addition to the ECPIP and the Directive, the Commission has undertaken a broad range of actions at sectoral level and on cross-cutting issues. These include Directive 2016/1148/EU on the security of network and information systems, legislation on the security of electricity and gas supply[480] and Regulation 2019/452/EU establishing a framework for screening foreign direct investments coming into the EU.

Regarding national risk assessment, the recently published Reporting Guidelines[481] underline the need to include a variety of sensitive targets exposed to hazards and threats, and describe how prevention and preparedness measures to protect critical infrastructure are implemented at national level.

The EU supports Member States by providing financial support to critical infrastructure protection projects. The Horizon 2020 work programme for 2018-2020 includes a dedicated call for research on how to address combined physical and cyber threats to critical infrastructure. EU funding for protecting critical infrastructure is also provided through the Internal Security Fund – Police instrument. This instrument enables Member States to fund the protection of critical infrastructure through their national programmes and also provides direct funding for relevant projects as well as for actions carried out by the Commission's Joint Research Centre, including the operation of the European Reference Network for Critical Infrastructure Protection (ERNCIP)[482].

Looking ahead, the Commission will present a proposal for additional measures on protecting critical infrastructure before the end of 2020. It will be developed in coordination with other planned and ongoing initiatives in related sectors, notably the review of the Directive on the security of network and information systems and the cross-sectoral financial services act on operational and cyber resilience.

10. Industrial accidents

10.1. The risk and trends

Disasters that result from chemical accidents are unforeseen events involving hazardous substances. Hazardous industries include: i) petroleum oil refineries, ii) chemicals manufacturing/storage (including liquefied natural gas), iii) fireworks and explosive manufacturing/storage, iv) fuel storage and distribution, v) processing of metals, vi) production of pharmaceuticals, vii) waste treatment, and viii) small and medium-sized businesses and non-chemical-based businesses that use dangerous substances. The transporting of dangerous goods through a country's territory also presents a risk of a chemical accident.

The risk of an accident depends on the industrial site's activity and the volume and types of dangerous substances involved. The likelihood of an accident occurring depends on how well the risks are understood and managed. The interface between technology and humans adds complexity to risk management. Chemical accidents can have a wide variety of causes, such as human error, insufficient safety measures, deliberate malicious acts and natural hazards. The technological accidents caused by natural hazards are called 'Natech' accidents.

Historical accidents like Seveso (Italy, 1976), Bhopal (India, 1984), Schweizerhalle (Switzerland, 1986), Enschede (the

[479] SWD(2019) 310 final.

[480] Commission Regulation (EU) 2017/2196 establishing a network code on electricity emergency and restoration (Text with EEA relevance); Regulation (EU) 2019/941 on risk-preparedness in the electricity sector (Text with EEA relevance.); Review of current national rules and practices relating to risk preparedness in the area of security of electricity supply, Regulation (EU) 2017/1938 concerning measures to safeguard the security of gas supply (Text with EEA relevance); Directive (EU) 2016/1148 concerning measures for a high common level of security of network and information systems across the Union.

[481] Commission Notice (C/2019/8929) Reporting Guidelines on Disaster Risk Management, Art. 6(1)d of Decision No 1313/2013/EU2019/C 428/07, OJ C 428, 20.12.2019.

[482] See https://erncip-project.jrc.ec.europa.eu/about-erncip

Netherlands, 2000), Toulouse (France, 2001), Buncefield (UK, 2005) and Gorni Lom (Bulgaria, 2014) showed that such accidents can have serious consequences. The impacts of industrial accidents, irrespective of their cause, may include:

- fatalities and injuries of workers on-site and the surrounding population;
- damage to property and infrastructure on-site and in the surrounding area;
- disruption of essential services and transport networks;
- environmental contamination and potential cross-border pollution;
- health hazards (e.g. caused by the release of acute toxic substances);
- physical hazards (e.g. highly flammable substances, hazards caused by the release of explosives);
- substantial economic losses that may lead to bankruptcy or job losses; and
- transboundary environmental and health impacts.

When major accidents take place, ecological and economic costs are borne not only by the establishment affected, but also by the local community, the Member State concerned, and, potentially, neighbouring countries.

Box 25. Recent industrial disasters in the EU: explosion of an ethylene oxide reactor in Tarragona, Spain, January 2010

On 14 January 2020, an ethylene oxide reactor exploded in a chemical company located in a petrochemical complex in Tarragona, Spain. This chemical accident is one of the most serious in the history of the industrial complex, due to the loss of life and the impacts on the surrounding community. Three people died and eight suffered injuries, including severe burns. Of the three people who died, two were workers at the plant and the third was a resident of Tarragona, who was located two kilometres from the plant at the time of the accident. The accident caused a large fire on-site, which led to the external emergency plan for the chemical sector of Catalonia being activated. Other buildings and residences, including nearby schools, were affected by the explosion.

The accident generated serious concern among local people regarding the risks associated with high-hazard facilities in their community. It led to a public debate on safety, environmental risk and the management of chemical emergencies, as well as on the economic model of the Tarragona industrial complex. It raised questions about government and industry actions that should take place immediately following a chemical accident, highlighting the need to adapt the response to chemical emergencies to meet the unique risks associated with chemical accidents that occur close to a densely populated area. These issues are now being discussed at the highest level of government in Catalonia and may have implications for the managing of chemical risks in other urban industrial areas throughout the EU.

Source: Commission for the monitoring and evaluation of the IQOXE accident, March 2020[483].

Overall, the number of chemical incidents in OECD countries, representing the world's most industrialised economies, is high compared to non-OECD countries (*Figure 51*). At the same time, the severity of these accidents in terms of fatalities is much lower[484]. (*Figure 52*) This is an indication that action taken to control the risks of chemical accident has been successful in reducing deaths and injuries.

[483] Evaluation table and follow-up of the accident of the IQOXE Company in the petrochemical complex of Tarragona on January 14, 2020. Presented to the government and the media on 28 April 2020. Available at https://www.elnacional.cat/ca/economia/informe-accident-quimica-iqoxe-actualitzar-normes-seguretat-industrial_499542_102.html

[484] Wood, M. and L. Fabbri. Challenges and opportunities for assessing global progress in reducing chemical accident risks – Progress in Disaster Science. Volume 4. December 2019 –https://doi.org/10.1016/j.pdisas.2019.100044

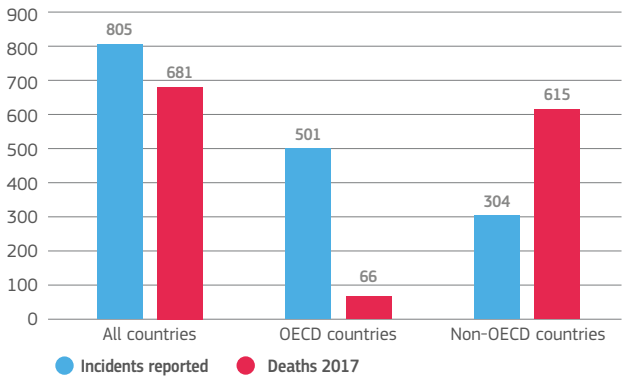


Figure 51. Chemical incidents and fatalities reported in the global media in 2017[485].

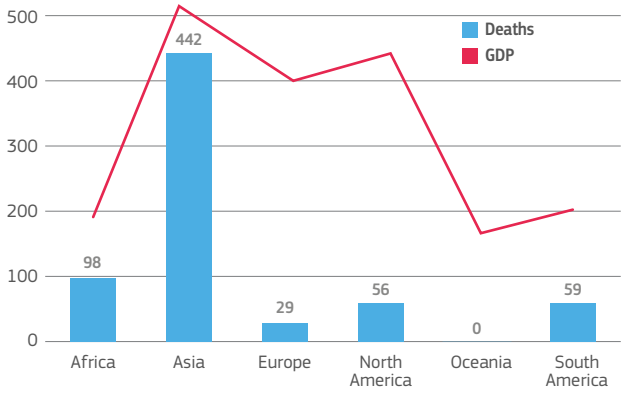


Figure 52. Chemical accident fatalities reported in the media by continent in 2017 (JRC-MAHB - March 2019)

In the EU, there are over 12 000 registered industrial establishments qualifying as high hazards, with over half of them located in Germany, France, Italy and the UK. Member States are obliged to report to the EU on accidents that fulfil certain criteria listed in Annex VI of the Seveso Directive. Those accidents are registered in the eMars portal[486]. Based on this reporting, on average, over 30 accidents take place every year (*Figure 53).* However, this data does not include accidents in hazardous facilities which are not covered by the EU Seveso Directive or incidents involving pipelines or transport.

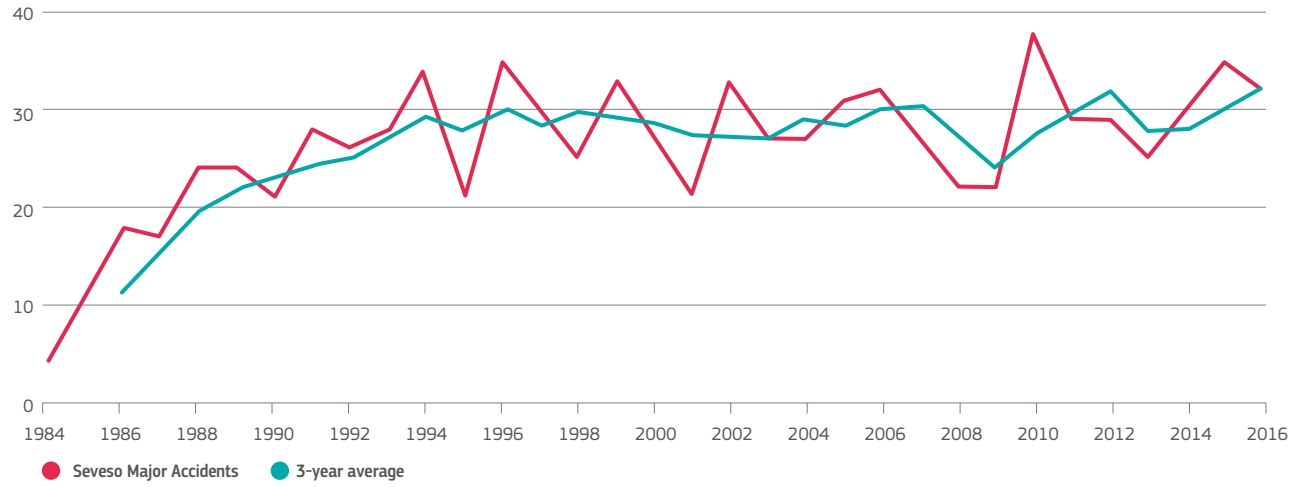


Figure 53. Major chemical accidents reported to the EU eMARS database 1984-2017[487]

[485] Idem.

[486] See https://emars.jrc.ec.europa.eu/en/emars/accident/search

[487] Wood, M. and L. Fabbri. Challenges and opportunities for assessing global progress in reducing chemical accident risks – Progress in Disaster Science. Volume 4. December 2019 –https://doi.org/10.1016/j.pdisas.2019.100044

While small-scale industrial accidents are common, the likelihood of major industrial events with a high impact remains low in the EU. This is largely thanks to the effectiveness of preventive government and industry interventions, or, in some countries, a relatively low presence of hazardous activities.

10.2. Key risk drivers

As long as chemicals and chemical processing remain important for our societies, accidents will continue to happen. The use and application of chemicals is actually growing, rather than decreasing. The expansion of urban areas and their proximity to high-risk industrial establishments increase their exposure to risk as well as the potential for human and economic consequences should there be an accident. The risk may further be exacerbated by climate change. More frequent extreme weather events, such as floods, droughts and heatwaves could damage or weaken infrastructure, triggering the release of dangerous substances, explosions, industrial fires or aggravating the effects of such accidents. Moreover, some technological adjustments due to climate change, such as a switch to alternative fuels including hydrogen and lithium batteries, may also introduce new risks or exposure to new risks. One recent example is an explosion that occurred at a hydrogen filling station for fuel cell cars in Norway in 2019.

The ageing of hazardous installations is another area of concern, receiving increasing attention over the past decade, both from public authorities and industry. Everything associated with an installation and its processes can age: equipment, procedures and technologies[488]. While fast economic and technological developments could provide new resources for strengthening the safety and security of industrial sites, they also generate new vulnerabilities. For example, process automation helps reduce the 'human error', but brings challenges related to programming errors or software glitches.

Shortcomings in risk management can themselves lead to disasters. The 2017 Chemical Accident Risks Seminar identified several factors affecting the effectiveness of chemical accident risk management: i) the insufficient use of safety performance indicators, ii) weaknesses in maintenance and mechanical integrity, iii) IT security and safety challenges, and iv) organisational change[489]. A change in ownership of hazardous facilities can increase the risk; if the process is not well managed, the condition and operation of the facility can deteriorate[490].

The combination of several risk factors can result in an increased risk of large accidents. For example, growing digitalisation, outsourcing of certain tasks (e.g. maintenance, safety and ICT) and fragmentation of expertise over several (sub)contractors increase the possibility of large-scale accidents occurring.

Another area that calls for special attention is the use of new substances, for example, bio-based chemicals, liquefied natural gas, compressed natural gas, nitrogen and nanoparticles[491]. These new substances and nanotechnology offer new possibilities for the industry, economy and society. However, the knowledge of related risks to public health and the environment is still relatively limited.

Lastly, malicious activities, such as cyberattacks, can target industrial sites. However, knowledge and tools to support inspections and oversight of cyber safety and security at EU Seveso sites are not widely available[492].

[488] Organisation for Economic Cooperation and Development. OECD report on Ageing of Hazardous Installations – ENV/JM/MONO(2017)9 – 16 March 2017. Available at http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2017)9&doclanguage=en

[489] Wood, M. H., 2017 Chemical Accident Risks Seminar and Training Workshop: Summary Report of Proceedings and Outcomes, Luxembourg: Publications Office of the European Union, 2017, ISBN 978-92-79-76909-2, doi:10.2760/441341, PUBSY No. JRC109442. Available at https://minerva.jrc.ec.europa.eu/en/shorturl/minerva/reportchemical_accident_risks_seminar_and_training_workshopsfinaldraftonlinev3pdf

[490] Organisation for Economic Cooperation and Development. Guidance on Change of Ownership in Hazardous Facilities. 2017. Available at https://www.oecd.org/chemicalsafety/chemical-accidents/oecd-guidance-on-change-of-ownership-in-hazardous-facilities.pdf

[491] NRA by NL.

[492] Wood, M., M. Hailwood, L. Allford, and Z. Gyenes. 2017. Chapter 3.12. Technological risks: Chemical accidents in Poljanšek, K., Marin Ferrer, M., De Groeve, T., Clark, I., (Eds.), 2017. Science for disaster risk management 2017: knowing better and losing less. EUR 28034 EN, Publications. https://drmkc.jrc.ec.europa.eu/portals/0/Knowledge/ScienceforDRM/ch03_s04/ch03_s04_subch0312.pdf

10.3. Industrial accidents in national risk assessments

Industrial risk in NRAs 2015

Industrial risk in NRAs 2018/2019

Industrial accidents are considered to be a major risk in Europe, with 27 countries including this in their of national risk assessments. When assessing the risk of industrial accidents, many Member States refer to and make use of the data gathered under the EU Seveso Directive. Overall, the likelihood and impact of an industrial accident are assessed at a rather similar level across Member States: the likelihood is estimated as being low and the estimated impact ranges from medium to high. Several Member States deem that an industrial accident that occurs as a cascading effect from other adverse events could have a high impact. Some Member States underline the territorial nature of this risk by assessing it as 'moderate' at national level, but high at regional/local level, where industrial establishments are located. In the most recent national risk assessments, there has been little change in assessed risk levels compared to the 2015 assessments.

10.4. Addressing the risk: EU actions

In the EU, major chemical accident risks are regulated by the provisions of the Seveso III Directive. The Directive[493] on controlling major accident hazards involving dangerous substances requires stringent safety measures to be implemented to prevent major accidents from occurring and, in case they cannot be prevented, to effectively mitigate their consequences for human health and the environment. The Seveso Directive also encourages the reporting of near misses and accidents, which is useful for learning purposes.

In line with the Seveso Directive, operators handling dangerous substances above certain thresholds must i) notify the relevant national authorities of their activities, ii) submit safety reports, iii) establish a safety management system and iv) set up an internal emergency plan. Member States have to ensure that members of the public who are likely to be affected by an industrial accident are regularly informed and that they have permanent access to relevant information, including that provided electronically. The responsible national authorities must ensure that external emergency plans are in place for the surrounding areas and that mitigation measures are planned. Regular inspections must be carried out. The objectives of prevention and control of major-accident hazards in land-use planning must also be taken into account.

[493] Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC, 24.7.2012, OJ L 197, pp. 1–37.

The Seveso Directive explicitly requires that environmental hazards, such as floods and earthquakes, are routinely identified and evaluated. In areas that are excluded from its scope, the Seveso III Directive is complemented by other legislation, such as the Mining Waste Directive[494] or the legislation on the transport of dangerous substances[495].

The Convention of the United Nations on the Transboundary Effects of Industrial Accidents, which was approved on behalf of the EU by Council Decision 98/685/EC, provides for measures to prevent, prepare for, and respond to industrial accidents that are capable of causing transboundary impacts on the environment and human health.

The EU has several other legal instruments that indirectly address Natech risks. Examples include the European Critical Infrastructure Directive[496], the Offshore Safety Directive[497], the Water Framework Directive[498] and the Floods Directive[499].

From the regulatory side, the Commission continues to examine whether there are significant gaps in the existing regulatory framework, in particular regarding new and emerging risks arising from other activities or from specific dangerous substances. Recently, the European Commission has fostered the exchange and analysis of new risks emerging in the rapidly changing oil and gas industry. Publications and events on the topic include the EU Good Practice Report on managing risks at liquefied natural gas and liquefied petroleum gas sites[500], and associated 'lessons learned' bulletins[501]. A seminar hosted by the European Commission in May 2019 in Sibiu, Romania addressed risks associated with biogas production and underground gas storage sites.

Various EU funding instruments support the research being carried out on the risks of industrial accidents. The Horizon Europe research programme for 2021-2027 will allocate, under pillar 2 'Global Challenges and Industrial Competiveness', EUR 52.7 billion to support the research carried out on boosting technological and industrial capacities. In the LIFE sub-programme 'Environment and Resource Efficiency', one of the thematic priorities supports the implementation of the Seveso III Directive. Lastly, the Digital Europe programme (EUR 9.2 billion) could boost investments in cybersecurity, high-performance computing and data, artificial intelligence, and advanced digital skills.

The JRC has developed a number of tools to support national authorities in assessing the risk of industrial accidents. RAPID-N is an online risk assessment tool operating since 2012, which allows for a quick analysis and mapping of the risk of Natech accidents both at local and regional levels. Accident Damage Analysis Module, also known as ADAM, is a software application for assessing the physical effects of an industrial accident resulting from an unintended release of a dangerous substance.

494 Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from extractive industries and amending Directive 2004/35/EC, 11.4.2006, OJ L 102, pp.15-34.

495 Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods, 30.9.2008, OJ L 260, pp. 13-59.

496 European Union, Council Directive 2008/114/EC on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection, O.J. Eur. Union (2008) L 345/75-82.

497 European Union, Directive 2013/30/EU of the European Parliament and of the Council on safety of offshore oil and gas operations and amending Directive 2004/ 35/EC, Off. J. Eur. Union (2013) L 178/66-106.

498 European Communities, Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy, O.J. Eur. Commun. (2000) L327/1-72.

499 European Union, Directive 2007/60/EC of the European Parliament and of the Council, on the assessment and management of flood risks, O.J. Eur. Union (2007) L 288/27-34.

500 Liquefied petroleum gas (LPG) and liquefied natural gas (LNG) sites. Seveso inspection series. Good practices report. Available at https://minerva.jrc.ec.europa.eu/en/shorturl/minerva/mjvcypruslnglpgv2pdf

501 The European Commission. Chemical accident information for preventing accidents. Lessons Learned Bulletins. Available at https://minerva.jrc.ec.europa.eu/en/shorturl/minerva/lessons_learned_from_major_accidents

11. Terrorism

11.1. The threat and trends

The terrorist threat in the EU remains high although the level varies across Member States. While the number of fatalities from terrorist acts has fallen since 2016, the number of failed, foiled and successful attacks as well as the number of arrests highlight the continued threat (*Figure 54*).

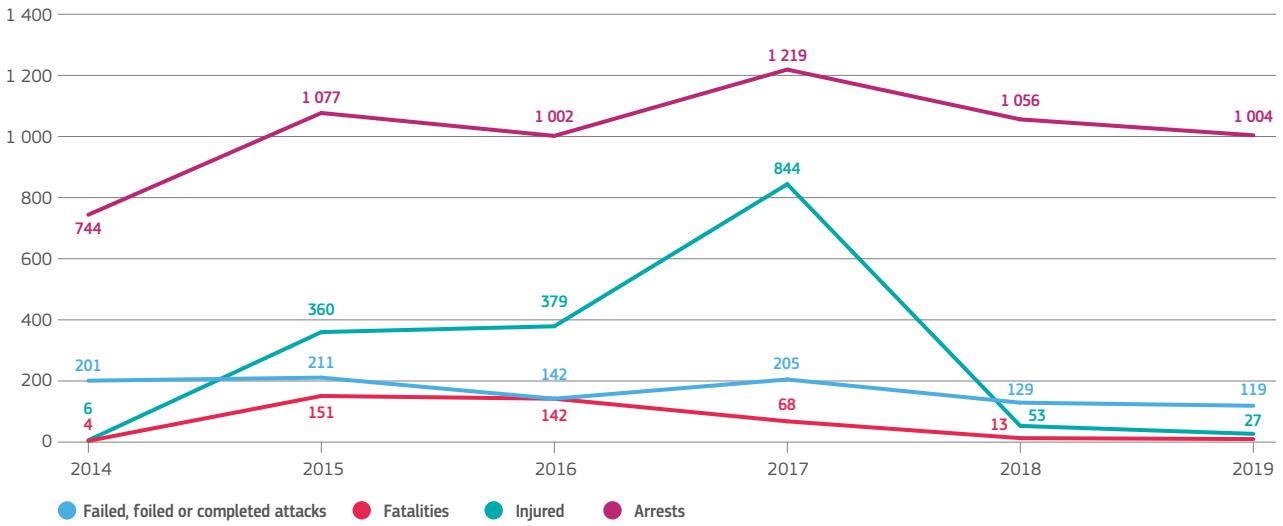


Figure 54. Terrorism in the EU 2014–2019. Source: EUROPOL[502]

The threat is rapidly evolving and is multifaceted due to the complex and fragmented nature of the global terror threat. Jihadist terrorism is one of the main threats to the EU through the activities of structured terrorist groups or cells and home-grown individuals who act alone, inspired by jihadist propaganda. The military defeat of the so-called IS Caliphate in Syria and Iraq has not necessarily resulted in the threat diminishing; rather, it has made the situation regarding threats more complex and fragmented. In addition to the risk posed by returning foreign terrorist fighters, the EU is confronted with the threat posed by home-grown radicalised individuals who follow IS and Al-Qaida propaganda that calls for more attacks.

Besides jihadism, other forms of terrorism are also a threat to the security of people in the EU. There is still ethno-nationalist and separatist terrorism in some Member States, as well as left-wing/anarchist terrorism and right-wing extremism (*Figure 55*). Although extreme right-wing terrorism is not a new phenomenon, recently there has been an increase in its frequency and lethality of attacks. While the violent right-wing extremist scene is very diverse across EU Member States[503], all right-wing extremists prey on fears of perceived attempts to Islamicise society and the loss of national identity.

[502] EUROPOL. EU Terrorism Situation and Trend Reports 2015-2020. Available at https://www.europol.europa.eu/activities-services/main-reports?rt[0]=282

[503] EUROPOL. European Union Terrorism Situation and Trend Report 2020. Available at https://www.europol.europa.eu/activities-services/main-reports/european-union-terrorism-situation-and-trend-report-te-sat-2020

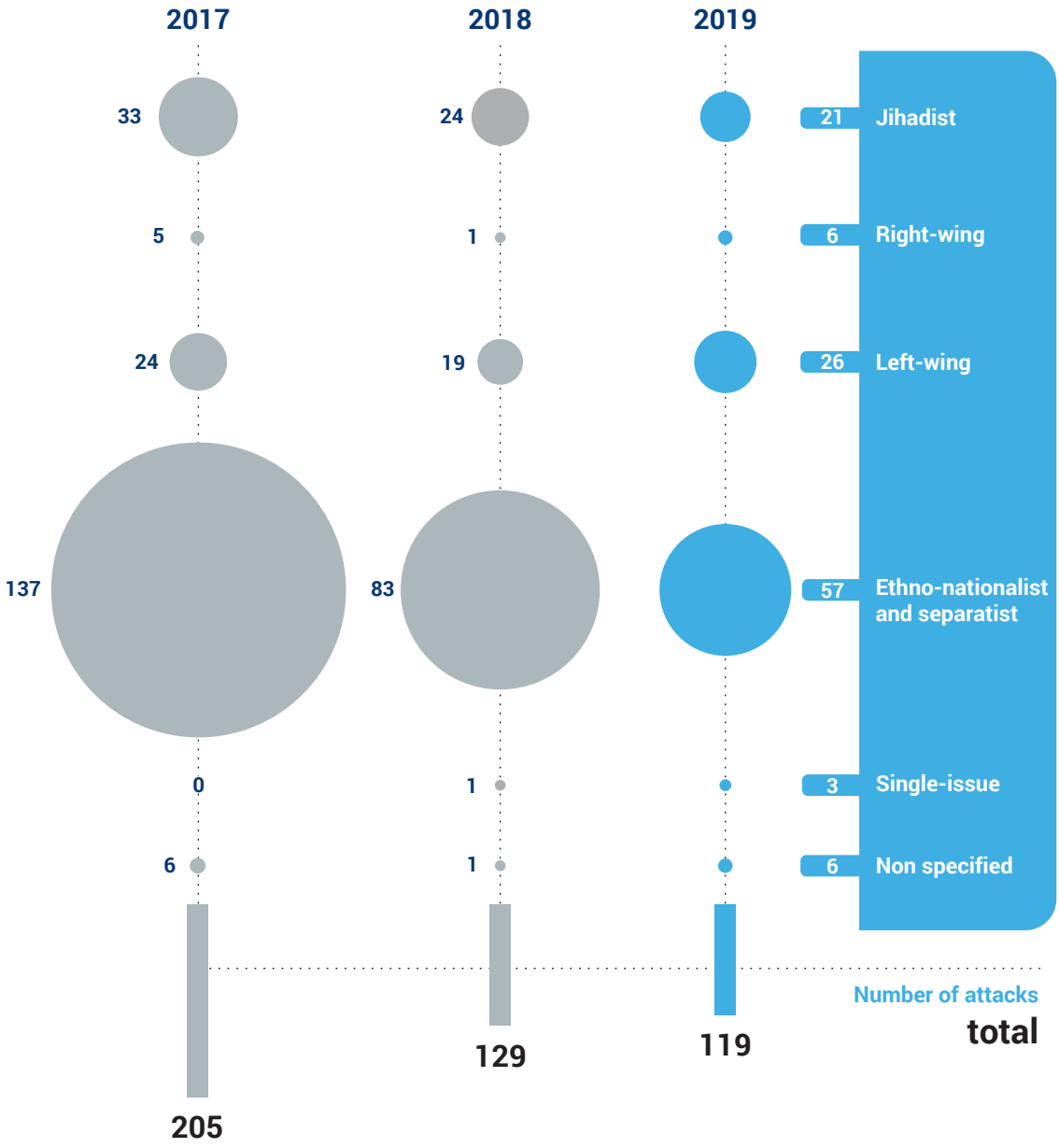


Figure 55. Terrorist attacks from 2017 to 2019 by affiliation. Source: EUROPOL[504]

So far, most of the terrorist attacks and plots have relied on non-sophisticated weaponry and methods (bladed weapons, car ramming) and targeted public spaces (concert halls, public venues, transport hubs, supermarkets). Such methods, in particular car ramming in mass events, can and have caused mass casualties. The use of vehicles as a weapon is expected to continue, as such attacks are easily planned and require minimal expertise, and a variety of vehicles can be easily accessed[505].

The availability of new technologies (e.g. encrypted communications, drones, 3D printing) increase the terrorists' capacity to mount attacks. The emerging risks are associated with terrorists' access to technologies and

[504] Ibid

[505] Bordin, G., Hristova, M., Luque-Perez, E. (eds.), Security and Defence Research in the European Union: A landscape review — Executive summary, EUR 29864 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-11591-5, doi:10.2760/388606, JRC117742.

substances which can significantly increase their capabilities and the impact of terrorist attacks, such as:

- access to chemical, biological, radiological or nuclear (CBRN) agents;
- use of unmanned aerial systems for planning and carrying out attacks against either soft or hard targets.

The likelihood of more complex attacks involving CBRN agents remain low, but they cannot be excluded. In recent years, an increase in CBRN terrorist propaganda, tutorials and threats has been observed online[506]. There were also cases of terrorists planning and sometimes even producing material for non-conventional attacks. These attempts have relied on low technology methods, using precursors that are relatively easy to obtain and simple production processes.

Chemical substances (plant-based toxins, toxic industrial chemicals, gas-forming chemicals) are the main substances of concern[507]. In the coming years, new technologies might make a difference when it comes to biological agents. There is a risk that novel gene-editing technologies (e.g. CRISPR) [508] and synthetic biology could be used to develop destructive biological weapons, such as new infectious viruses. While this is unlikely at present, the biohacking[509] movement is developing quickly; technical barriers and manufacturing costs are also lowering. Regarding the radioactive substances, there are no recent indications that terrorists are interested in using them. However, there are some vulnerabilities that can be exploited (e.g. radioactive sources in medical facilities).

Unmanned aerial vehicles (e.g. drones) can be used as a delivery mechanism for CBRN agents, as in 2015, when a drone carrying traces of radioactivity was found on the roof of the Japanese Prime Minister's official residence. Moreover, numerous cases of drones flying over nuclear plants highlight the vulnerability of this type of infrastructure to conventional attacks, with drones used as a delivery device for explosives.

In the future, a number of challenges are expected, related to i) the return of foreign fighters from Syria, Iraq and Libya, ii) extremist preachers, iii) internet propaganda, iv) extremist content on satellite TV, v) radicalisation of second and third generation migrants due to a failure to include them in society, vi) culture shock experienced by non-integrated first generation migrants, and vii) an increase in violence and hate speech by far-right groups[510].

[506] Europol. European Union Terrorism Situation and Trend Report 2019. Te-Sat. - https://www.europol.europa.eu/activities-services/main-reports/terrorism-situation-and-trend-report-2019-te-sat

[507] Andrew Zammit. Operation Silves: Inside the 2017 Islamic State Sydney Plane Plot. - CTC Sentinel - April 2020, Volume 13, Issue 4. Available at https://ctc.usma.edu/operation-silves-inside-the-2017-islamic-state-sydney-plane-plot/

[508] Gene editing or genome editing is a group of technologies that give scientists the ability to change an organism's DNA. These technologies allow genetic material to be added, removed, or altered at particular locations in the genome. Several approaches to genome editing have been developed, one of them being CRISPR. Source: MedlinePlus, available at https://medlineplus.gov/genetics/understanding/genomicresearch/genomeediting/

[509] Biohacking — also known as DIY biology — can be defined as the attempt to manipulate human brain and body in order to optimise cognitive or physical performance, outside the realm of traditional medicine, often using opportunities offered by new technologies.

[510] Bordin, G., Hristova, M., Luque-Perez, E. (eds.), Security and Defence Research in the European Union: A landscape review — Executive summary, EUR 29864 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-11591-5, doi:10.2760/388606, JRC117742.

11.2. Terrorism threat in national risk assessments

Terrorism threat in NRAs 2015

Terrorism risk threat NRAs 2018/2019

National disaster risk assessments differ depending on whether their scope covers or excludes man-made malign threats. As regards terrorism, 19 national submissions analyse this threat. In most cases, the detailed assessment of scenarios is considered to be confidential information. In general terms, the reports analyse a range of recently seen and potential threats: attacks targeting groups of people (crowded places or selected social groups), critical infrastructure or high-risk installations. The threat is linked both to international terrorism and domestic extremism. Potential perpetrators can be either state or non-state groups, 'lone wolves', small groups or structured networks of terrorist organisations. Weapons and technologies that could be employed vary. The reviews of recent terrorist attacks note that the majority of them relied on low-cost methods, such as the use of vehicles and bladed weapons. Other conventional weapons – explosives and firearms – can and have been used. The use of unmanned aerial vehicles cannot be excluded as they are easy to use and are of low cost. Several national submissions also consider threats related to CBRN substances, but overall these do not feature prominently. Some of the scenarios mentioned include the 2018 Novichok nerve agent attack in Salisbury in the UK or the potential explosion of a 'dirty bomb' that combines conventional explosives with radioactive material.

By its nature, a terror attack is difficult to predict. National risk assessments diverge depending on whether they attempt at or disclose an estimation of the likelihood of a terrorist act. Where they do, the threat tends to be qualified in the medium to high range. Relatively simple attacks carried out by individuals or small groups inspired by jihadism are regarded as the most likely form of terrorist attack. The impact depends on the scenario under consideration. A serious terrorist attack could have severe consequences, such as death, injury, psychological distress, economic losses and the disruption of critical infrastructure. Beyond the immediate damage, a terror attack is likely to trigger the general feeling of insecurity among people and might also help polarise and instil hatred towards certain groups.

Latest editions of national risk assessments convey a concern that the terrorist threat has been evolving rapidly and becoming more complex over recent years. In addition to 'lone wolf' attacks, there have been examples of coordinated terrorist acts; new types of agents have been employed, and some of the foiled plots were more serious than before. The challenges are expected to remain; continuing instability in the EU's neighbourhood, the rise of extremist views and possibilities offered by new technologies are some of the factors that fuel the threat.

11.3. Addressing the threat: EU actions

Building on the 2015 European Agenda on Security[511], the Commission is working towards an effective and genuine Security Union. There has been significant work to step up information exchange and operational cooperation among Member States' law enforcement and judicial authorities, with the support of EU Agencies. EU Agencies (notably Europol and CEPOL) as well as specialised networks and EU initiatives (e.g. ATLAS, the High Risk Security Network, AIRPOL, and the EU Forum on the protection of public spaces under the EU action plan to support the protection of public spaces) provide operational support to Member States' authorities and enable good practices to be exchanged.

The prevention and countering of violent extremism is a priority. The work of the High-Level Commission Expert Group on Radicalisation continues to guide the Commission's work in this field. A radicalisation awareness network (RAN)[512] brings together experts from all Member States to improve the skills needed to address violent extremism. Through the EU Internet Forum, bringing together governments, Europol and the biggest technology and social media companies, there is cooperation on ensuring that illegal content, including terrorist propaganda, is taken down as quickly as possible (see also section 12 of this Annex on cyber threats). A proposal for a regulation on preventing the dissemination of terrorist content online was proposed in 2018.

Drawing on lessons from recent attacks and the development of terrorism threats, the Commission has focused its action on strengthening resilience. Recent initiatives include:

- an action plan to boost preparedness against CBRN security risks[513];
- an action plan to support the protection of public spaces[514];
- a new regulation on the marketing and use of explosives precursors[515];
- work to increase transport security, notably in the rail and aviation sectors[516]; and
- a new Commission legislative proposal for additional measures on protecting critical infrastructure, which is scheduled for the last quarter of 2020 (see also section 9 of this Annex for more details on protecting critical infrastructure).

A Directive on combating terrorism[517] was adopted in 2017, with the transposition deadline of 8 September 2018. The Directive establishes minimum rules on defining criminal offences and sanctions for terrorist offences, as well as measures for protecting, supporting and providing assistance to victims of terrorism. The Anti-Money laundering Directive, which is part of the comprehensive range of measures to combat terrorist financing, was updated in 2018[518].

An action plan to boost preparedness against CBRN security risks was adopted in October 2017[519]. The objectives of the action plan are:

- to improve Member States' capabilities in the CBRN area;
- reduce the accessibility of CBRN materials;

[511] COM(2015) 185.

[512] The European Commission. Radicalisation Awareness Network. Available at https://ec.europa.eu/home-affairs/what-we-do/networks/radicalisation_awareness_network_en

[513] COM(2017) 610.

[514] COM(2017) 61.2

[515] Regulation (EU) 2019/1148 of the European Parliament and of the Council of 20 June 2019 on the marketing and use of explosives precursors, amending Regulation (EC) No 1907/2006 and repealing Regulation (EU) No 98/2013.

[516] For instance on background checks: C/2019/136, Commission Implementing Regulation (EU) 2019/2013 of 23 January 2019.

[517] Directive (EU) 2017/541 of the European Parliament and of the Council of 15 March 2017 on combating terrorism and replacing Council Framework Decision 2002/475/JHA and amending Council Decision 2005/671/JHA. OJ L 88; 31.3.2017, p.6.

[518] Directive (EU) 2018/843 of the European Parliament and of the Council of 30 May 2018 amending Directive (EU) 2015/849 on the prevention of the use of the financial system for the purposes of money laundering or terrorist financing, and amending Directives 2009/138/EC and 2013/36/EU. OJL 156, 19.6.18, p.43;

[519] COM(2017) 610 final.

- boost preparedness and response to security incidents;
- build stronger links with key international and regional partners (US, NATO, Interpol and IAEA) and exchange knowledge of CBRN risks at EU level.

In light of this, numerous activities, including workshops, training, detection trials and exercises have been implemented.

Following the 2018 Salisbury attack, there has been a significant increase in the political awareness of and attention paid to CBRN risks. In March 2018, the European Council adopted conclusions on the Salisbury attack, inviting the Commission and the High Representative to report on progress made to address hybrid threats and strengthen resilience to CBRN risks. In June 2018, the Commission adopted the 15th Security Union Progress Report as well as a joint report with the High Representative on hybrid threats.

Financial support for capacity building and research activities needed to protect public spaces and address CBRN threats is provided through the EU Internal Security Fund and the Horizon 2020 programme.

12. Cyber threats

12.1. The threat and trends

As societies are increasingly dependent on electronic networks and information systems, the protection of cyber space has become a major concern for European countries. All forms of cybercrime have been significantly increasing and evolving over recent years. According to the EUROPOL's 2019 Internet Organised Crime Threat Assessment (IOCTA), cybercrime is becoming more aggressive and confrontational across various its forms, including high-tech crimes, data breeches and sexual extortion[520]. The latest trends, as discussed in the IOCTA 2020, include the amplification of existing cyber threats during the COVID-19 crisis[521].

Ransomware and banking trojans remain the top malware threats, a trend unlikely to change for the foreseeable future. The 2017 WannaCry and NotPetya attacks not only happened on an unprecedented scale affecting a wide range of key industries and critical infrastructures worldwide, but also resulted in a high cost to the global economy. According to the European Union Agency for Cybersecurity (ENISA), the WannaCry ransomware campaign affected more than 150 countries and over 230 000 systems.

Distributed-Denial-of-Service (DDoS) continues to be a threat for businesses and public organisations. This situation is aggravated by the fact that 'crime-as-a-service', connecting specialist providers of cybercrime tools and services (ransomware, DDoS, etc.) with organised groups, has become the leading model of the digital underground.

Data remains a key commodity for cyber-criminals. It is procured for immediate financial gain in many cases, but, increasingly, it is also acquired in order to commit more complex fraud, encrypted for ransom or used directly for extortion.

Social engineering remains one of the main methods used for committing cybercrime. Phishing aimed at high value targets, for example, refined variants of spear phishing such as CEO fraud, have become a key threat.

EMV[522] (chip and PIN), geo-blocking and other industry measures continue to reduce card-present fraud within the EU, but logical and malware attacks directly against ATMs evolve and proliferate. Organised crime groups are starting to manipulate or compromise payments involving contactless (NFC[523]) cards.

The production and distribution of child sexual exploitation material continues to increase. The use of end-to-end encrypted platforms for sharing media, coupled with the use of largely anonymous payment systems, has helped the live streaming of child abuse to escalate. The increasing number of young children with access to the internet

[520] EUROPOL. Internet Organised Crime Threat Assessment (iOCTA) 2019. Available at https://www.europol.europa.eu/activities-services/main-reports/internet-organised-crime-threat-assessment-iocta-2019

[521] EUROPOL Internet Organised Crime Threat Assessment (iOCTA) 2020 – Available at https://www.europol.europa.eu/sites/default/files/documents/internet_organised_crime_threat_assessment_iocta_2020.pdf

[522] Europay, Mastercard, Visa.

[523] Near Field Communication.

and its social media platforms increases the risk of online sexual coercion and extortion.

The dark net continues to facilitate criminals involved in a range of illicit activities, such as the exchange of child sexual exploitation material. The extent to which extremist groups currently use cyber methods to conduct attacks is relatively limited, but the availability of cybercrime tools and services provides them with the opportunity to use these techniques. Furthermore, the dark net can be used to purchase illicit commodities such as firearms.

Digital currencies are used to pay for criminal products and services in the digital underground economy and the dark net. Digital currencies have also become the standard payment solution for extortion payments. Cryptojacking (the exploitation of internet users' bandwidth and processing power to mine cryptocurrencies) has emerged as a new trend creating revenue for attackers, further motivating them to hack legitimate websites.

Economic damage caused by cybercrime can only be estimated due to the under-reporting of cybercrime, different perceptions of what cybercrime is, and difficulties in quantifying damages. The WannaCry attacks alone are estimated to have cost global economies roughly USD 4 billion[524].

There has been increasing concern over semantic attacks such as disinformation and its role in hybrid threats and actions that challenge the integrity of democratic processes. For example, the East Stratcom Task Force[525], launched in 2015 by the European Union External Action Service (EEAS) to address Russia's disinformation campaigns, reported 1 000 cases of disinformation detected between January and June 2019. This is compared to 434 cases reported for the same period in 2018.

Box 26. Special Eurobarometer on cyber security, 2020[526]

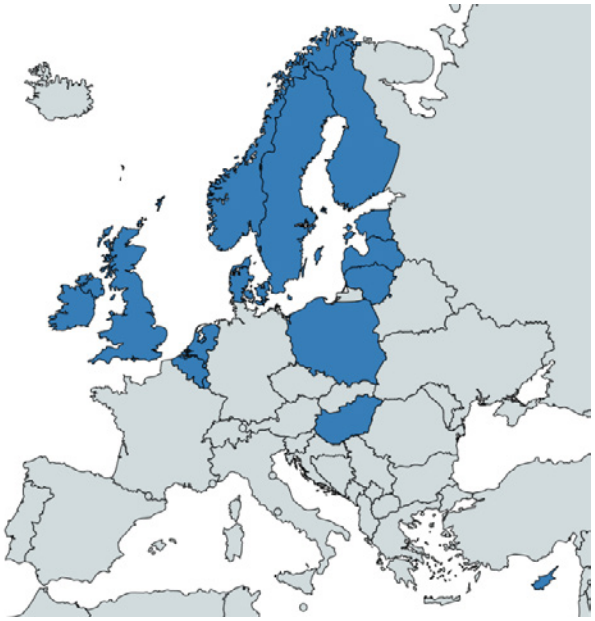
The 2020 Special Eurobarometer on 'Europeans' attitudes towards cyber security' confirmed that there is a high level of concern across the EU about becoming a victim of a range of cybercrimes, such as identity theft, phishing, spam and malware, illegal online content, including child sexual abuse material, incitement to racial hatred or terrorist acts and glorification of violence, racism, and xenophobia. While daily internet use is rising, with more than three quarters of respondents (76%) using the internet each day, the percentage of people who feel able to protect themselves against cyber threats is falling. 76% of respondents believe that the risk of becoming a victim of cybercrime is increasing, while 68% are concerned that their online personal information is not kept secure by websites or public authorities. The survey suggests a need for improved public awareness of the steps people can take to protect themselves against cyber threats and the official channels for reporting cybercrimes.

[524] Beer J., "WannaCry" ransomware attack losses could reach $4 billion. 16 May 2017 – available at https://www.cbsnews.com/news/wannacry-ransomware-attacks-wannacry-virus-losses/

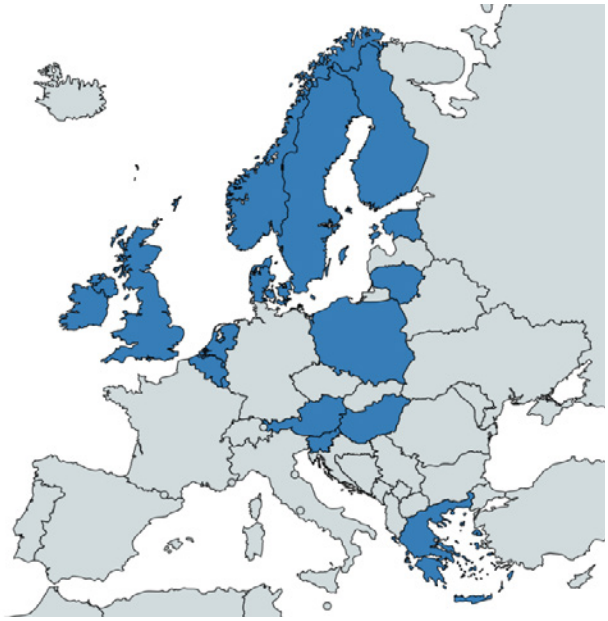
[525] The European External Action Service. Questions and Answers about the East StratCom Task Force – 5 December 2018 – available at https://eeas.europa.eu/headquarters/headquarters-homepage/2116/-questions-and-answers-about-the-east-stratcom-task-force_en

[526] Special Eurobarometer 499. Europeans' attitudes towards cyber security – January 2020 – available at https://data.europa.eu/euodp/en/data/dataset/S2249_92_2_499_ENG

12.2. Cyber threats in national risk assessments



Cyber threats risk in NRAs 2015



Cyber threats risk in NRAs 2018/2019

Sixteen of the submitted national risk assessments deal with cyber-related risks. Two risk assessments mentioned cyber threats for the first time, while one no longer referred to this threat. National disaster risk assessments differ in terms of the depth of analysis of cybercrime. Some assessments include only brief references to the risks related to cybercrime without an accompanying analysis, while others present more extensive analyses, scenarios and ranking of the threats.

Box 27. The diversity of cyber threats in national risk assessments

National risk assessments focus on different forms of cyber threats and/or use different terminology. Below is a non-exhaustive list of examples of threats covered in the national risk assessments.

- Cyberattacks – attempts to attack computers with malicious intent. Cyberattacks can take many forms. Examples mentioned include denial-of-service attacks, data burglary, disinformation, information network intelligence operations and other interferences with information networks targeting state and society.
- Cyberespionage – a supplementary tool to classical types of covert intelligence gathering that may target public authorities or private entities, high-tech and research intensive industries. The risk is deemed very high, with attacks occurring more frequently.
- Cybercrime – using information technologies to commit criminal acts against public authorities, businesses or individuals, often for economic gain. These types of activities occur daily. Examples include blackmailing through ransomware attacks and 'crime-as-a- service', whereby expertise on how to carry out cyberattacks is sold for criminal purposes, both which are increasing. The financial sector is an attractive target for cyber-criminals.
- Cyberterrorism – using information technologies to attract attention to the terrorist cause, inciting acts aimed at physical destruction or killing.
- Hacktivism – hacking the infrastructure of public institutions based on ideological beliefs.
- Disinformation - information warfare and propaganda; also seen as part of hybrid threats. This aims to systematically stir the public debate, fade out the boundaries between truth and lies, and weaken society's trust in public authorities or democratic values. This can be carried out by state or non-state groups or individuals.
- Digital sabotage or disruption of the internet - attacks on central functioning of the internet. Can potentially have far-reaching consequences for internet capacity and paralyse critical infrastructure, domestically and abroad. This can be carried out by remotely operated computers, and is considered a relatively new threat reflecting the increased competence of the attacker.
- Digital warfare and cyber conflicts are considered under geopolitical threats in some assessments.

According to the risk assessments that were received, cyber threats are growing, both in terms of the frequency of incidents and the increased vulnerability of society. The increased exposure and vulnerability of public authorities, individuals and businesses is due to increased dependency on digital solutions, ever increasing interconnectedness, and rapidly developing technologies. Non-intentional failures are also assessed in the national risk assessments, such as disruptions or vulnerabilities linked to digitalisation, major accidents, severe weather and space weather incidents.

Although risk assessments refer to cyber threats caused by natural phenomena, the predominant focus is nonetheless on attacks with malicious intent carried out by individuals, criminal organisations or state groups or individuals. The role that cyber space plays in enabling hybrid threats is receiving increased attention compared to the previous editions of national risk assessments. Some reports now refer to previous cyberattacks involving attempts to influence election results, manipulation of social media and attacks on public services.

According to some risk assessments, the full extent of cyber incidents cannot be measured with sufficient certainty. This is linked both to the problem of under-reporting and confidentiality issues. For example, information on hybrid attacks is often not public. Large-scale cybercrime that targets the business community may be under-reported as companies may have concerns about the implications for their public image. Some risk assessments specify the degree of reliability of their risk analysis, which in most cases is estimated as moderately reliable.

National risk assessments conclude that although the frequency and intensity of the attacks are often very high, with daily incidents reported in many assessments, the impacts have so far have been relatively low, due to the prevention and protection measures taken. Notwithstanding, the worst-case scenarios included in some risk assessments point to potentially very serious consequences. National submissions examine a range of strategic targets that could potentially be threatened: i) critical infrastructure (including healthcare and emergency services), ii) financial infrastructure, iii) electronic

communication infrastructure, iv) transport, (v) industry, and v) government services. In addition to the economic impact, cyber threats may also lead to loss of life (e.g. fatalities due to the breakdown of an emergency call number). They can have cascading effects, causing other types of risks, notably disruption of critical infrastructure. As infrastructure and systems often depend on international connections, serious disruptions in one Member State may affect other countries. Lastly, malicious acts, such as cybercrime, and large-scale violations of data protection by criminals or state operators also erode trust in services of the digital society.

12.3. Addressing cyber threats: EU actions

Directive (EU) 2016/1148 on the Security of Network and Information Systems (the NIS Directive), in force since 2016, is the first EU-wide law on cybersecurity and serves as a basis to ensure a high level of security of network and information systems across the EU. This is achieved through action taken on several fronts. Firstly, steps are taken to improve cybersecurity capabilities at national level, for example, by developing national cybersecurity strategies, setting up computer security incident response teams and close monitoring of how well a Member State is protected against cyber threats and incidents. Secondly, cooperation at EU-level has been boosted, facilitated, among other things, by the designation of a single point of contact for cross-border cooperation in each Member State. Thirdly, the Directive sets out risk management and incident reporting obligations for operators of essential services and digital service providers, including in specific sectors, such as healthcare, transport, energy, banking and financial market infrastructure. At the time of writing, the Directive was undergoing a review, to be finalised by the end of 2020, in line with the key policy objective of the Commission to make 'Europe fit for the digital age'.

Building on the 2013 European Union cybersecurity strategy, in 2017 the Commission and the EEAS published the Joint Communication 'Resilience, Deterrence and Defence: Building strong cybersecurity for the EU'[527]. It was part of the cybersecurity package, which set out actions to i) make the EU more resilient to cyberattacks, ii) help the EU respond to cyberattacks in terms of protection and deterrence, and iii) support cooperation on cybersecurity and cyber defence globally. Legislative and policy initiatives included in the cybersecurity package and containing the resilience component are presented below.

- The proposal for a Cybersecurity Act Regulation, which was adopted by the European Parliament and Council in April 2019[528], established the EU framework for cybersecurity certification of products, services and processes. It also strengthened the mandate of the EU Agency for Cybersecurity (ENISA), making it better equipped to support Member States in tackling cybersecurity threats and attacks.

- The Communication on 'Making the most of NIS'[529] provided guidance for a harmonised transposition of Directive (EU) 2016/1148 on the Security of Network and Information Systems.

- The Commission Recommendation on Coordinated Response to Large Scale Cybersecurity Incidents and Crises[530] set out a blueprint for an EU coordinated emergency response in the event of a large-scale cross-border cyber incident or crisis.

In 2018, the Commission put forward a proposal to establish a European Cybersecurity Network and a Competence Centre[531]. The aim of this proposal is to help the EU retain and develop the cybersecurity technological and industrial capacity necessary to secure the digital single market. This initiative is in line with the key objective of increasing the competitiveness of the EU's cybersecurity industry and turning cybersecurity into a competitive advantage of other European industries. The Centre and its activities will help public authorities and industries across Member States to prevent and respond to cyber threats more effectively, including by facilitating access to

[527] JOIN/2017/0450 final.

[528] Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013 (Cybersecurity Act).

[529] COM(2017) 476 final/2.

[530] C(2017) 6100 final.

[531] Proposal for a Regulation of the European Parliament and of the Council establishing the European Cybersecurity Industrial, Technology and Research Competence Centre and the Network of National Coordination Centres COM(2018) 630 final.

cybersecurity expertise and state of the art products and solutions. A political agreement between the European Parliament and the Council on the establishment of the Centre is expected by the end of 2020.

In 2018, the Commission also adopted two legislative proposals to improve cross-border access to electronic evidence[532]. This is essential for criminal investigations of cybercrime, terrorism and other serious forms of crime, as evidence is increasingly (only) available in electronic form on infrastructure operated by private sector service providers in other countries. More than half of all investigations now include a cross-border request to access e-evidence.

In 2019, a new Directive on combating fraud and counterfeiting of non-cash means of payment was adopted[533]. The Directive shows its added value regarding fraud committed online through 'non-corporeal' means of payment. It presents an opportunity to deal with the transnational nature of organised crime groups active in non-cash payment fraud.

As technologies develop, new cyber threats and resilience needs emerge. 5G networks in particular will play an important role in the development of the European society and economy. They are expected to offer vast economic opportunities and to serve as a basis for the digital and green transformation in areas such as transport, energy, manufacturing, health, agriculture and media. However, the roll-out of 5G networks will also generate new security risks. To address these concerns, in March 2019 the Commission issued the Recommendation on 'Cybersecurity of 5G networks' [534], inviting Member States to complete national risk assessments of 5G networks, work together at EU level on a coordinated EU-wide risk assessment and to prepare a toolbox of possible mitigating measures.

The EU coordinated risk assessment of the cybersecurity of 5G networks was published on 9 October 2019.[535] It identified the main cyber threats and potential perpetrators, the most sensitive assets, key vulnerabilities and a number of strategic risks. On 29 January 2020, the NIS Cooperation Group published the EU toolbox of mitigating measures for addressing the risks identified.[536] These measures include actions aimed at promoting the sustainability and diversity of the 5G supply chain and protecting the EU's technological sovereignty. The 2020 Communication on 'Secure 5G deployment in the EU – Implementing the EU toolbox'[537] endorsed the conclusions of the EU toolbox and announced that the Commission would undertake actions to ensure the implementation of the mitigating measures of the toolbox in the areas falling under its responsibility.

Action at EU level has also been stepped up to address growing concerns and challenges linked to disinformation online. In 2018, the Commission published the Communication 'Tackling online disinformation: a European approach'[538]. It outlined the key principles and objectives which should guide actions to raise public awareness about disinformation and tackle the phenomenon effectively, as well as the specific measures which the Commission intended to take in this regard. The Communication was followed by the 'Action Plan against Disinformation'[539] that the Commission and the European External Action Service jointly adopted at the end of 2018. The Action Plan is based on four pillars: (i) improving the capabilities of the EU institutions to detect, analyse and expose disinformation; (ii) strengthening coordinated and joint responses to disinformation; (iii) mobilising private sector to tackle

[532] Proposal for a Regulation of The European Parliament and of the Council on European Production and Preservation Orders for electronic evidence in criminal matters, COM(2018)225 final; Proposal for a Directive of the European Parliament and of the Council laying down harmonised rules on the appointment of legal representatives for the purpose of gathering evidence in criminal proceedings, COM(2018)226 final.

[533] Directive (EU) 2019/713 of the European Parliament and of the Council of 17 April 2019 on combating fraud and counterfeiting of non-cash means of payment and replacing Council Framework Decision 2001/413/JHA. OJ L 123, 10.5.2019, p. 18–29.

[534] Commission Recommendation (EU) 2019/534 of 26 March 2019 Cybersecurity of 5G networks. – Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019H0534

[535] NIS Cooperation Group. EU coordinated risk assessment of the cybersecurity of 5G networks. Report. – 9 October 2019 – Available at https://ec.europa.eu/commission/presscorner/detail/en/IP_19_6049

[536] The Cybersecurity of 5G networks – EU Toolbox of Risk Mitigating Measures. – 29 January 2020. – Available at: https://ec.europa.eu/digital-single-market/en/nis-cooperation-group

[537] COM(2020) 50 final.

[538] COM(2018) 236 final.

[539] JOIN(2018) 36 final.

disinformation; and (iv) raising awareness and improving societal resilience.

One of the accomplishments under the Action Plan is a 'Code of practice against disinformation' agreed with online platforms, leading social networks and advertising industry in October 2018. Another example of action taken under the Action Plan is the package of measures adopted to ensure free and fair European elections. In the run-up to the European Parliament elections in 2019, Facebook, Google and Twitter committed to report on their progress every month. Between January and May 2019, platforms took action against thousands of accounts that had violated anti-disinformation and advertising policies.[540]

Other measures to fight disinformation include the launch of an Observatory for Social Media Analysis in 2018 and setting up of a Rapid Alert System[541] in March 2019. Campaigns were launched to raise awareness of risks linked to disinformation, boost societal resilience, improve media literacy and support quality journalism and independent fact-checking.

EU funding is available to support Member States' action on tackling the wide-ranging cyber threats. Member States can benefit from the EU's Internal Security Fund-Police to address cybercrime risk, both through the national programmes and direct actions via calls for proposals. In addition, the Horizon 2020 call for proposal on the fight against crime and terrorism covers cybercrime risks, both in terms of their societal and technological aspects.

Looking ahead, a new EU cybersecurity strategy will aim to boost EU-level cooperation, knowledge and capacity in cybersecurity. It will outline the approach to enhancing the EU cyberresilience and autonomy in the face of technological and societal changes, taking into account the geopolitical dimension of cyber space, acceleration of digitisation and vulnerabilities revealed by the COVID-19 pandemic. The new cybersecurity strategy will accompany the review of the NIS Directive and the proposal for additional measures on critical infrastructure protection.

[540] For example, Google took action against 130.000 EU-based accounts that violated policies to fight misinformation. Facebook reported 1.2 million actions violating policies on ads and content and disabled 2.2 billion fake accounts. Twitter rejected more than 16.000 ads and challenged 77 million spam or fake accounts. YouTube removed over 3.39 million channels. For more details, see the report on progress of the Action Plan against Disinformation, published in June 2019 and available at https://ec.europa.eu/commission/sites/beta-political/files/factsheet_disinfo_elex_140619_final.pdf

[541] Rapid alert system strengthening coordinated and joint responses to disinformation. – Available at https://eeas.europa.eu/sites/eeas/files/ras_factsheet_march_2019_0.pdf

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