COUNCIL OF THE EUROPEAN UNION

Brussels, 8 April 2014

8703/14
ADD 2

PROCIV 30
COHAFA 42
DEVGEN 90
ONU 37
ENV 363

COVER NOTE

from:	Secretary-General of the European Commission, signed by Mr Jordi AYET PUIGARNAU, Director
date of receipt:	8 April 2014
to:	Mr Uwe CORSEPIUS, Secretary-General of the Council of the European Union
No Cion doc.:	SWD(2014) 134 final
Subject:	Commission Staff Working Document Overview of natural and man-made disaster risks in the EU Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions The post 2015 Hyogo Framework for Action: Managing risks to achieve resilience

Delegations will find attached Commission document .

Encl.: SWD(2014) 134 final

EUROPEAN
COMMISSION

Brussels, 8.4.2014
SWD(2014) 134 final

COMMISSION STAFF WORKING DOCUMENT

Overview of natural and man-made disaster risks in the EU

Accompanying the document

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions

The post 2015 Hyogo Framework for Action: Managing risks to achieve resilience

{COM(2014) 216 final}
{SWD(2014) 133 final}

TABLE OF CONTENTS

Overview of natural and man-made disaster risks in the EU

1 INTRODUCTION

In 2009, a framework for European Union (EU) cooperation on disaster prevention across all types of natural and man-made hazards was agreed upon by the EU Member States in Council conclusions[1]. A fundamental building block for this prevention framework is risk assessment, which together with risk analysis constitutes the basis for a successful disaster risk management (DRM) strategy. The Council set out several steps to build a risk assessment policy. Firstly, in 2010 the European Commission prepared guidelines on risk assessment[2] based on research and good practice examples that could support Member States in the preparation of national risk assessments (NRAs). Secondly, Member States agreed to prepare or update their own national risk assessments and to share with the Commission and other Member States the results of these assessments[3].

Subsequently in 2011[4], the Council asked the Commission to develop an overview of natural and man-made disaster risks the EU may face in the future, based on national risk assessments. The overview would focus primarily on natural and man-made disaster risks which are 'shared', i.e. those with likely cross-border impacts, or those on a larger scale where impacts would be experienced by more than one Member State. It would also take into account, when relevant and possible, the future impacts of climate change and the need for climate change adaptation.

The overview would help determine areas for cooperation between Member States on disaster prevention and preparedness; it could feed into planning for civil protection preparedness and response; and provide lessons for other policy areas such as climate change adaptation, research and regional policies. Examples of its relevance to other policy initiatives are the linkages with ongoing macro-regional programmes through which several European countries are cooperating in the field of DRM, such as the Baltic[5] and Danube[6] strategies, or the marine spatial planning/sea basin strategies.

Cooperation in the EU on risk assessment is to be enhanced and developed following adoption of the new Civil Protection Mechanism[7]. Member States are required to

---

[1] Council conclusions on a Community framework on disaster prevention within the EU, *2979th Justice and Home Affairs Council meeting*, Brussels, 30.11.2009.
[2] European Commission, *Commission Staff Working Document on Risk Assessment and Mapping Guidelines for Disaster Management*, SEC(2010) 1626 final, Brussels, 21.12.2010.
[3] 28 EU Member States as well as 4 third countries participating in the Civil Protection Mechanism (Norway, Iceland, Liechtenstein and the former Yugoslav Republic of Macedonia) have been invited to report on their national risk assessments.
[4] Council conclusions on further developing risk assessment for disaster management within the European Union, *3081st Justice and Home Affairs Council meeting*, Brussels, 11.4.2011.
[5] The EU Strategy for the Baltic Sea Region is a macro-regional initiative regrouping Sweden, Denmark, Estonia, Finland, Germany, Germany, Latvia, Lithuania and Poland. Within the Strategy, a project aiming at the development of scenarios and the identification of gaps for all main hazards in the region has been developed (project 14.3), http://www.balticsea-region.eu/.
[6] The EU Strategy for the Danube region includes Germany, Austria, Slovakia, Czech Republic, Hungary, Slovenia, Romania, Croatia and Bulgaria within the EU and Serbia, Bosnia and Herzegovina, Montenegro, Moldova and Ukraine outside. This macro-regional strategy focuses on a range of priority areas, including priority area no.5 looking at environmental risks, http://www.danube-region.eu/.
[7] Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism, *Official Journal of the European Union,* L (347), 20.12.2013.

complete risk assessments at national or appropriate sub-national level and make available to the Commission a summary of the relevant elements by 22 December 2015 and every three years thereafter (Art.5). The legislation also confirms the importance of the risk overview and emphasizes its links to other policies. This document is a first risk overview, based, at this stage and for this version, on the Council conclusions provisions as well as the new Civil Protection Mechanism legislation.

Furthermore, the Commission/High Representative joint proposal for the implementation of the Solidarity Clause[8] includes a provision for the regular production by the Commission and the High Representative of a joint integrated threat assessment report at Union level as of 2015, building on the monitoring, interpretation and sharing of information provided by Member States.[9] The proposal is currently being discussed in Council.

This first version of an overview of natural and man-made disaster risks in the EU is based, so far, on contributions by 17 Member States: Bulgaria (BG), Cyprus (CY), Czech Republic (CZ), Denmark (DK), Estonia (EE), Germany (DE), Greece (EL), Hungary (HU), Ireland (IE), Italy (IT), Lithuania (LT), Netherlands (NL), Poland (PL), Romania (RO), Slovenia (SI), Sweden (SE), United Kingdom (UK) - and Norway (NO) (see annex 1). Of these 18 contributions, 11 are complete or well-advanced NRAs or summaries thereof[10]. Seven Member States are yet to assess their identified risks and produce finalised versions of their NRAs[11] (see annex 3). Based on current contributions, Commission services consider that sufficient information is available to start identifying the most important disaster risks that a large number of Member States are addressing, focusing in particular on risks with a cross-border dimension. In addition, information on some natural hazards, collected at a European level for research projects, for other sectoral policies, including climate change adaptation, and for the forecasting tools developed by the Joint Research Centre (JRC), can complement the national risk assessments.

This document should be seen as a first step towards a full overview and the beginning of a medium term cooperation process with Member States. This overview has been created based on contributions of a limited number of Member States, and remains a living document in which future contributions by Member States - including both first and updated versions of national risks assessments – will feed into future versions of this document.

1.1 Scope of the Overview

According to Council conclusions, the EU overview of risks should "*identify […] risks or types of risks that are shared by Member States or regions in different Member States"*[12]. To do so, it makes *"use of the relevant expertise of the Member States"* and

[8] Treaty on the Functioning of the European Union, *Official Journal of the European Union*, C(115), 9.5.2008, Article 222.
[9] European Commission, High Representative of the European Union for Foreign Affairs and Security Policy, *Joint proposal for a Council Decision on the arrangements for the implementation by the Union of the Solidarity clause*, JOIN(2012) 039 final, 21.12.2012, Article 8.
[10] DK, EE, IE, LT, HU, NL, NO, PL, SE, SI, UK.
[11] BG, CY, CZ, DE, EL, IT, RO; 14 countries have not yet provided some form of contribution: Austria (AT), Belgium (BE), Spain (ES),former Yugoslav Republic of Macedonia, Croatia (HR), Finland (FI), France (FR), Iceland (IS), Lichtenstein (LI), Luxembourg (LU), Latvia (LV), Malta (MT), Portugal (PT), Slovakia (SK).
[12] Council Conclusions, 30.11.2009, *op.cit*.

"report[s] on information that Member States have provided with regard to risks"[13]. The overview will contribute to a shared understanding of where disaster risks lie in Europe, what their impact and likelihood are and how countries can work together to identify, assess and manage risks. In fact, the production of a cross-sectoral overview of disaster risks in the EU is enshrined in the civil protection legislation adopted in 2013, which calls upon the Commission to *"establish and regularly update a cross-sectoral overview and map of natural and man-made disaster risks the Union may face, by 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"*.[14]

The overview focuses on a limited number of major *disaster* risks faced by EU Member States, resulting from an analysis of the first available national risk assessments and progress reports provided by Member States. Probability/likelihood of occurrence, magnitude of impact, the cross-border dimension of risks, and emerging risks are analysed based on available information.

In this overview, the main comparison between Member States' risk assessments is based on an analysis of the main natural and man-made hazards identified and a first analysis of their respective risk assessments (focusing on consequences/impacts and probability/likelihood of risk scenarios). 'Consequence' or 'impact' are understood as negative effects of the disaster or risk expressed in terms of human impacts, economic/infrastructure impacts and environmental impacts. The terms 'probability' or 'likelihood' are understood as the probability or likelihood of the risk occurring or taking place in the future. As set out in the guidelines on risk assessment and mapping prepared by the Commission, national scenario-building and risk identification would need to consider at least all significant natural and man-made hazards that "*would occur on average once or more every 100 years (i.e. annual probability of 1% or more) and for which the consequences represent significant potential impacts, i.e. number of affected people greater than 50, economic and environmental costs above €100 million, and political/social impact considered significant or very serious*".[15]

The timeframe for most of the risk assessments submitted is set at five to ten years ahead[16]. This time period allows for a more reliable assessment of the probability of natural and man-made hazards occurring, and corresponds approximately to timescales for the funding of potential actions addressing risks. The choice of a defined shorter timeframe may also help reduce comparability issues for risks which are important in the shorter term as compared to risks which may materialise only in the longer term.

Finally, emerging risks, such as space weather events, climate change and antimicrobial resistance for which the impacts are still difficult to assess, will be addressed in this overview. Future versions of the overview could increase in scope to address a wider range of risks and emerging risks. Further work on an EU overview of risks could further provide lessons for other policies and identify potential for future cooperation in disaster risk management at European, regional and national levels.

1.2 Information sources for the Overview

[13] Council Conclusions, 11.4.2011, *op.cit.*
[14] Decision No 1313/2013/EU, 20.12.2013, *op.cit.,* Article 5(c).
[15] SEC(2010) 1626 final, 21.12.2010, *op.cit.,* 24.
[16] *Ibid.*

As mentioned above, the main information sources are the national risk assessments which Member States have shared with the Commission as part of Civil Protection policy. This has been complemented with projects, systems, methodologies and datasets managed by the Commission (JRC)[17] and collected through the Global Disaster Alert and Coordination system (GDACS) for earthquakes and tsunamis, the European Flood Awareness System (EFAS), the European Forest Fire Information System (EFFIS) and the European Drought Observatory (EDO), as well as information collected for EU funded research projects on natural hazards and climate change.

Additional information comes from other EU policies including Agriculture and Rural Development, Climate, Development, Energy, Enterprise, Environment, Health and Consumers, Home Affairs, Internal Market, Research and Innovation, Integrated Maritime Policy and Transport.

For purposes of comparison, the World Economic Forum's Global Risk Report[18], which provides the positions and views of the Forum's network of leading experts on global risks, has been used. Relevant material produced by other institutions such as Interpol, the Organisation for Economic Co-operation and Development (OECD), and United Nations (UN) agencies have been consulted to complete the background information on each of the natural and man-made hazards addressed.

Terms and concepts in this document are in line with the Commission's guidelines on risk assessment.[19]

1.3 Main Natural and Man-made Disaster Risks Addressed

The overview is based on the main risks addressed in the national risk assessments and progress reports provided by Member States. An analysis of the 18 national contributions currently at the European Commission's disposal identifies 25 hazards, both natural and man-made (malicious and non-malicious). The depth of assessment (listing, scenarios, and risk matrix analysis) of each hazard risk varies across the risk assessments and progress reports submitted. To avoid comparability complications in working with the limited material available, this overview identifies the frequency of denomination of each risk. This first-step analysis will draw a picture of the geographical distribution of the main risks across Europe based on Member States' contributions[20] and points to areas of potential for further work and cooperation amongst Member States.

In fact, a number of these hazards are also assessed in Global Risks Landscapes 2014 produced in the World Economic Forum's Global Risk Report[21]. These converging assessments would confirm the relevance of the risks addressed in this overview.

The frequency of denomination of the hazards identified is represented below:

---

[17] Joint Research Centre, "Overview of Disaster Risks that the EU faces", *JRC Technical Report*, 2013, available at: http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/29598/1/lb-na-25822-en-n.pdf.

[18] World Economic Forum, *Insight Report: Global risks 2014. Ninth Edition,* 2014, available at: http://www3.weforum.org/docs/WEF_GlobalRisks_Report_2014.pdf.

[19] SEC(2010) 1626 final, 21.12.2010, *op.cit.,* 9-12.

[20] Out of a total of 32 countries contributing to this overview, only 18 have so far submitted an NRA or progress report, thus creating gaps in the geographical distribution of risks.

[21] World Economic Forum, 2014, *op.cit.,* 16.

Hazard	Frequency of denomination
Natural hazards	
Floods	17
Severe weather	15
Pandemics/epidemics	14
Livestock epidemics	12
Wild/Forest fires	11
Earthquakes	9
Landslides	7
Droughts	6
Space weather	4
Volcanic eruptions	3
Harmful organisms[22]	3
Tsunamis	1
Man-made hazards	
Industrial accidents	15
Nuclear/radiological accidents	13
Transport accidents	10
Cyber attacks	9
Terrorist attacks	8
Loss of critical infrastructure	7
Public disorder	5
Marine/coastal pollution	3
Water/food contamination	3
CBRN attacks	3
Refugees/unmanaged migration	2
Environmental pollution	1
Crisis outside the EU	1

Table 1: Frequency of denomination of main risks in national risk assessments (DG ECHO, 2014)

Of all the hazards identified in the NRA, a list of the 12 most addressed hazards can be drawn. The main hazards listed below will be addressed in this overview:

Category	Hazard
Natural hazards	**Floods** **Severe weather** **Wild/Forest fires** **Earthquakes** **Pandemics/epidemics** **Livestock epidemics**

[22] The risk of harmful organisms, as assessed by Lithuania, refers to the penetration and spread of harmful organisms through the international trading of plants, plant products and other objects to which phitosanitary control is necessary. Hazardous algal blooms are another example of harmful organisms.

Man-made hazards	**Industrial accidents** **Nuclear/radiological accidents** **Transport accidents** **Loss of critical infrastructure** **Cyber attacks** **Terrorist attacks**

Table 2: Main risks in the European Union addressed in the overview (DG ECHO, 2014)

This section compares the way the countries contributing to the overview have analysed the 12 most commonly occurring hazards above. For each hazard, the criteria for analysis used, the scenarios identified and the evaluation of each relevant national risk assessment were examined.

The national classifications and terminologies of the types of hazards addressed may differ. It has, in some cases, been necessary to group 'similar' hazards within one hazard category: floods cover coastal, inland and flash floods; severe weather includes storms, heat waves, snow/ice, and rain; pandemics and epidemics are addressed together and refer to the main current pandemic risk in Europe, influenza; industrial and chemical accidents and the release of chemical substances are grouped together, as are nuclear and radiological accidents and the release of radioactive substances; transport accidents include air, land, maritime and hazardous material transport accidents; the variants of cyber security threats are regrouped under cyber-attacks, as is also the case for terrorist attacks.

When possible, observations are drawn from the risk matrices used by Member States to plot the different likelihood/probability and impact/consequence scores (see annex 2). Only nine of the 18 contributions received present assessment results in the form of a risk matrix and scenarios used for the risk evaluation (see annexes 3 & 4). The variety and varying severity of these risk scenarios complicate at this stage the comparability of results from Member States contributions. Moreover, although the matrices that have been sent have generally measured probability and impact on a 5x5 scale, these categories differ and could lead to different interpretations of severity of risks and, ultimately, different policy conclusions. Some of the matrices are numbered 1 to 5 or use letters A to E – 1 and A being low probability/impact and 5 and E being high probability/impact. Other matrices use various terms to express the ranges: probability is measured from highly unlikely to highly likely or from very low to very high; impact is measured from limited/insignificant to catastrophic, very low to very high, minimal to very significant, or from very low to very severe. The available assessment criteria and scores are gathered in overview tables in annex to this document (see annex 4).

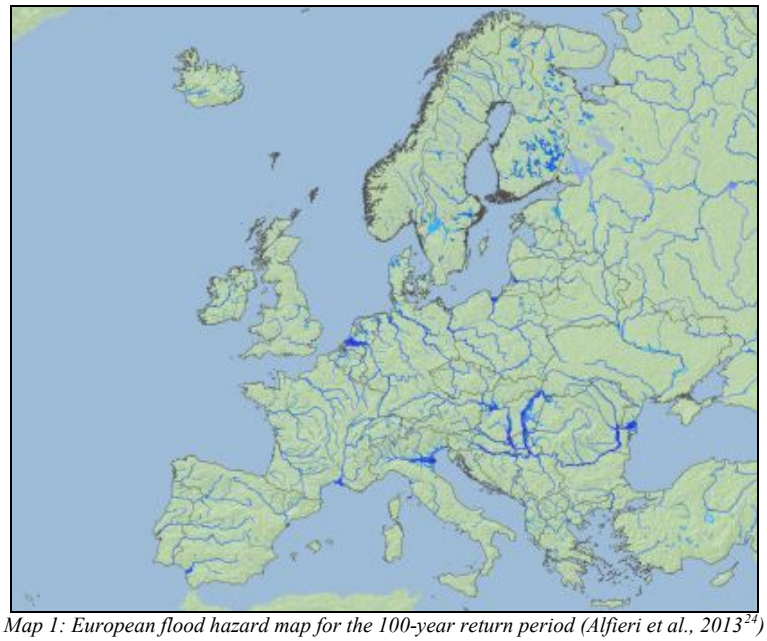
2 NATURAL DISASTER RISKS

2.1 Floods

Floods are defined as "the temporary covering by water of land not normally covered by water".[23] These occur frequently in all parts of the EU in the form of river, flash and urban floods, as well as coastal flooding. Flooding is considered a complex process involving socio-economic and physical factors. Often, its impact is localised and limited

[23] Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks, *Official Journal of the European Union,* L (288), 6.11.2007, Article 2.

in time; however, floods can also affect vast areas, cross borders, and maintain high water levels for weeks. Flooding can result in environmental conditions that are breeding grounds for diseases. While flood risks in some areas of Europe can be considered not to be significant – areas of low population density, low economic or ecological value – many areas are prone to one or more flood types. Increased soil sealing and ecosystem degradation can be further factors aggravating the flood risk. The map below, produced by the JRC, provides an overview of river flood hazard in Europe. It shows areas that could potentially be inundated by a 100-year flood assuming no flood protection up to that event:



Map 1: European flood hazard map for the 100-year return period (Alfieri et al., 2013[24])

Flooding has significant consequences on people, businesses, infrastructure and services, but also to the environment and cultural heritage. A report by the European Environment Agency (EEA) studying the floods in Europe for 1998-2009 identifies 213 recorded events, over 1,100 casualties and overall economic losses at about €60 billion[25]. Over the past years, major floods have occurred in Europe such as the ones in Southern and Eastern Germany and neighbouring countries in 2013 (estimated costs of €12 billion)[26], the Elbe basin in 2002 (estimated costs of €20 billion), in Italy, France and the Swiss Alps in 2000 (economic costs of €12 billion) and in the United Kingdom in 2007 (accumulated losses of €4 billion).[27] In fact, the number of floods and heavy precipitation in Northern and North-eastern Europe has increased in recent years, in line with current projections of increased extreme events resulting from climate change as further discussed in section 4.[28]

There is a long history of policy and operational action in Member States to address flooding. This has been complemented by EU legislation and other policy measures. In

[24] Alfieri L., et al., Advances in pan-European flood hazard mapping, *Hydrological Processes*, 2013.
[25] European Environment Agency (EEA), "Mapping the impacts of the natural hazards", *Technical Report No. 13/2010*, 2010, 64-65.
[26] Munich RE, "Floods dominate natural catastrophe statistics in first half of 2013",*Press Release,* 9.7.2013, available at: http://www.munichre.com/en/media_relations/press_releases/2013/2013_07_09_press_release.aspx.
[27] EEA, 2010, *op.cit.,* 64-65.
[28] European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions on an EU Strategy on adaptation to climate change*, COM(2013) 216 final, Brussels, 16.4.2013, 2.

2007, the EU adopted a floods directive[29] on the assessment and management of flood risks. Its main provisions include the requirement to assess if all river basin districts (or other unit of management including coastal areas) are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures (flood management plans) to reduce this flood risk.

Article 4 of the Floods Directive requires Member States to undertake a Preliminary Flood Risk Assessment for each River Basin District, Unit of Management, or the portion of an international River Basin District or Unit of Management lying within their territory. The Preliminary Flood Risk Assessment requires an assessment of past and potential future floods and associated adverse consequences to identify Areas of Potentially Significant Flood Risk, which will be based on available or readily derivable information including the requirements specified in the Floods Directive (Article 4).

The figure below summarises the time periods covered by the reported historic flood events. The oldest flood event dated back to 100 AD from Spain. Most of the oldest events relate to fluvial and sea water floods which are presumably the most notable historically because of the extent of the damage that they may cause to human health. The highest proportion of recent flood events are for pluvial and groundwater floods (around 60% of events were recorded from 2000 onwards).

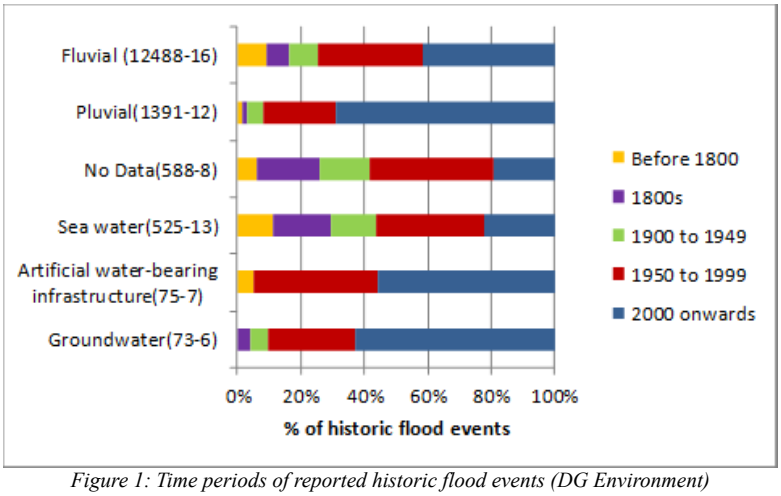


Figure 1: Time periods of reported historic flood events (DG Environment)
(figure based on data AT, BG, CY, CZ, DE, DK, EE, EL, ES, FI, FR, HU, IE, LT, LV, MT, PL, RO, SE, SI, SK, UK. The numbers in brackets after the source of flood refers to the number of events reported from the number of MS)

The preliminary results show that the most common source of reported historical flood events is by far fluvial (67% of events) followed by pluvial (19%) and sea water (17%). The least common is for artificial water bearing infrastructure and groundwater (both 1%). The most common mechanism is natural exceedance (54% of events). In terms of potential future floods the most common source of flooding is again fluvial (76% of reported events) and the least from groundwater and artificial water bearing infrastructure (both 2%). Natural exceedance was the most common mechanism (45%).

Economic consequences were most frequently reported for historic floods (for 42% of events at the aggregated level), this was followed by human health (28%), environment (14%) and cultural heritage (6%).[30] These patterns may be the result of the fact that, historically, the impacts of floods have been reported in terms of effects on the economy

[29] Directive 2007/60/EC, 6.11.2007, *op.cit.*
[30] The information presented above is based on a preliminary assessment; results presented are themselves preliminary.

and human health rather than on the environment and cultural heritage: information on the latter two categories may simply not be available for many events. Furthermore, vulnerability of the population should be taken into account: for instance, socio-economic deprived populations, with worse housing conditions, might be expected to be more vulnerable.

The legislation reinforces the opportunities for the public to access this information and the active involvement of interested parties in the planning process**.** The EU has also supported the development of a flood early warning system for the whole of the EU - European Flood Awareness System (EFAS)[31] that provides overview information for riverine floods and flash floods to the European Commission's Emergency Response Coordination Centre (ERCC) and complements flood forecasting activities carried out in the Member States. EFAS is part of the COPERNICUS Emergency Management Service[32]. Flood prevention, preparedness and response actions are a major priority for EU civil protection policy, particularly in the context of the EU Civil Protection Mechanism.[33]

Flood risk is also being addressed in research projects financed under the European Commission's Sixth Framework Programme (FP6)[34] such as project FLOODsite (Integrated Flood Risk Analysis and Management Methodologies)[35], as well as the Seventh Framework Programme (FP7)[36] such as the projects CORFU (Collaborative research on flood resilience in urban areas)[37] and IMPRINTS (Improving preparedness and risk management for flash floods and debris flow events)[38]. More recently, the STARFLOOD (Strengthening and redesigning European flood risk practices towards appropriate and resilient flood risk governance arrangements)[39] will explore new ways of partnerships in risk management. Other projects focusing on flood risk are funded by ECHO under its Civil Protection Financial Instrument through annual call for proposals for Prevention and Preparedness in Civil Protection, such as projects HAREN (Hazard Assessment based on Rainfall European Nowcasts) in 2011, FLOOD CBA (Knowledge Platform for Assessing the Costs and Benefits of Flood Prevention Measures) in 2012, and ACHELOUS (Action of Contrast to Hydraulic Emergency in Local Urban Site) in 2013[40].

Analysis of national risk assessments

Flood risk is identified by 16 Member States (all contributing Member States but Cyprus) and Norway. In the NRAs submitted by Denmark and Norway, flood hazards are addressed as one of various severe weather phenomena to underline their occurrence

[31] European Flood Awareness System (EFAS), http://www.efas.eu/.
[32] See: www.emergency.copernicus.eu.
[33] Modules of participating states' assets, composed of experts and equipment provided on a voluntary basis and to be mobilised at very short notice can provide expertise and technical capacity for high-capacity pumping and other flood response actions.
[34] EU Sixth Framework Programme for Research and Technological Development (2002-2006), http://ec.europa.eu/research/fp6/index_en.cfm.
[35] FLOODsite Project, http://www.floodsite.net/.
[36] EU Seventh Framework Programme for Research and Technological Development (2007-2013), http://ec.europa.eu/research/fp7/index_en.cfm.
[37] CORFU Project, http://www.corfu-fp7.eu/.
[38] IMPRINTS Project, http://www.imprints-fp7.eu/en/projectes.
[39] STARFLOOD Project, http://www.starflood.eu/.
[40] European Commission, Directorate General for Humanitarian Aid and Civil protection (DG ECHO), available at: http://ec.europa.eu/echo/funding/financial_instrument_en.htm.

as a cascade effect of other risks such as precipitation and storms. Bulgaria is in the process of assessing this risk.

A number of submitted NRAs underline the particularly high risk associated with floods. Indeed, floods are categorised as the highest risk hazard in Poland and in Hungary, one of four highest risk hazards in the United Kingdom and one of five in Ireland. This hazard is one of two most affecting Italy and the Czech Republic. Slovenia ranks floods as one of two highest risk hazards; Estonia ranks it as 'high' risk, while floods are ranked fourth in the Lithuania's priority ranking of potential hazards. In the case of the Netherlands and the United Kingdom, for which a distinction in the assessment is made between inland and coastal floods, worst credible case scenarios provided assess a higher risk for coastal over inland flooding.

Land use and management practices can influence the intensity of fluvial and pluvial floods, based on the different capacity of retention of water in soil and vegetation. For example, Denmark identifies the density of buildings and the amount of surfaced reinforced with asphalt or other surfacing material rendering seepage difficult as a condition in assessing the risk of floods.

Denmark and Norway address flood hazards under the category of severe weather. Denmark focuses on storm surges, characterised by a sudden rise in sea water level following heavy coastal storms, high tides and precipitation. Norway addresses floods as a direct consequence of heavy precipitation and winds. The scenario used by Sweden considers flooding as an event associated with the failure of a river dam, also considered a loss of critical infrastructure. All these cases thus underline the direct cascade effect between flooding and other related hazards.

Flood hazards can also constitute cross-border risks affecting more than one country. For instance, Hungary addresses the cross-border characteristic of floods by underlining that, as a transit country for many rivers located in the Carpathian Basin, 95% of flood waters in Hungary originate abroad.[41]

Six Member States provide a matrix assessing the risk of a flood scenario: Estonia, Ireland, Netherlands, Poland, Slovenia, and the United Kingdom. Notwithstanding the different forms of floods assessed (inland, coastal, combination of both) and the absence/variety of scenarios used in NRAs, an assessment of risk matrices suggests consensus over the high risk level of this hazard. Impact of both coastal and inland flooding is assessed as moderate/serious or more across all six national assessments. The level of probability is also assessed as moderate/serious or above across most assessments, with the exception of the Netherlands whose use of a worst-credible flood scenario incurs a comparatively lower likelihood of occurrence.

Moreover, NRAs submitted by Denmark, Hungary, Norway, Netherlands, United Kingdom point to the likely impact of climate change on extreme weather events and flood risks across the EU. According to the UK's National Risk Register, "*the rising temperatures and sea levels associated with climate change are likely to increase the frequency and severity of extreme weather events, and hence the flood risks across the UK*".[42] Norway's NRA states that the country has so far been spared from the most extreme floods, as low air temperatures limit low evaporation and precipitation and the country has large number of lakes and forests; nevertheless, increasing temperatures and

[41] Hungary, *National Disaster Risk Assessment*, 7.
[42] United Kingdom Cabinet Office, *National Risk Register of Civil Emergencies*, 2013, 16.

precipitation resulting from climate change may increase the risk of extreme floods.[43] The impact of climate change on floods is further explored in section 4.

Map 2: Participating states in the Union Mechanism assessing floods as a main risk hazard (DG ECHO, 2014)
(dark grey: participating states assessing hazard as a main risk; light grey: participating states not identifying this hazard in their submitted national risk assessments; white: countries for which no information is available)

2.2 Severe weather

A variety of meteorological phenomena can fall under the 'severe' or 'extreme weather' category, i.e. where they become disruptive and necessitate the intervention of emergency services and civil protection and/or lead to other natural disasters, such as flooding or drought. Investing in the development of Green Infrastructure[44] can help to increase resilience and reduce vulnerability. The severe weather phenomena commonly cited by European countries include storms/hurricanes, heat waves, cold spells, droughts, snow and/or ice and heavy rainfall.

Storms are natural phenomena consisting of strong winds and precipitation. Storms in Europe generally originate from extra-tropical cyclones resulting from warm subtropical air coming into contact with polar air over the Atlantic Ocean. Large differences in these pressure systems result in the formation of storms over western and central Europe; less frequently, these storms may progress southward and affect southern and south-eastern Europe. It is estimated that during 1998-2009 storms caused the death of over 700 people and were the most costly of all natural hazards in Europe in terms of losses. The environmental impacts of storms are also relevant: over 130 storm events have been identified as causing "noticeable damage" to forests in Europe in the past 60 years and storms are responsible for over 50% of all primary abiotic and biotic damage by volume from catastrophic events to forest in Europe.[45] Storms may also have important impacts on infrastructure, posing a challenge to transmission networks and renewable generators in the energy sector, as well as traffic disruption, traffic accidents

[43] Norway, *National Risk Assessment*, 11.
[44] European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions on Green Infrastructure (GI) — Enhancing Europe's Natural Capital*, COM (2013) 249 final, Brussels, 6.5.2013.
[45] Gardiner B., et al., "Destructive Storms in European Forests: Past and Forthcoming Impacts", Commission Report, *European Forest Institute*, 2010, 4, available at: http://ec.europa.eu/environment/forests/pdf/STORMS%20Final_Report.pdf.

and damage to installations of transport infrastructure.[46] While no trend of storms occurring has been identified, storm-related losses have increased in recent years due to increased exposure.[47] However, current projections of increased extreme events resulting from climate change indicate that the risk of storms in Europe will increase, as is further discussed in section 4.[48]

Some sector-specific policies both at European level (Green Paper on Forest Protection and Information in the EU[49]; proposal for a Directive establishing a framework for maritime spatial planning and integrated coastal management[50]) and national level have seen the light in recent years. Furthermore, further research on storm management has been carried out through FP7 funding such as projects MOTIVE on Models for Adaptive Forest Management[51] and MICORE working on the morphological impacts and coastal risks induced by extreme storm events.[52] Further research has started in 2013 on assessing European coastal threats in relation to extreme events in order to improve risk management and resilience: PEARL (Preparing for Extreme and Rare events in coastal regions)[53] and RISC-KIT (Resilience-Increasing Strategies for Coasts – toolKIT)[54]. The RISES-AM Project (Responses to coastal climate change: Innovative strategies for high end scenarios Adaptation and Mitigation)[55] considers future sea level rise in its wave modelling approach.

A period of extreme heat, or **heat wave**, is defined as a lengthy period of extraordinarily hot and/or humid weather patterns for a set region. No set thresholds exist as defining heat wave levels is region-specific. A tentative definition proposed by the World Health organisation (WHO) identifies a heat wave as "*a period when maximum apparent temperature and minimum temperature are over the 90th percentile of the monthly distribution for at least two days*".[56] In recent years, heat waves have been the extreme weather hazard that has had the largest impact in terms of loss of life. The most vulnerable populations are the elderly, the infirm and socio-economically deprived groups in dense urban environments. Urban heat islands may exacerbate the effects of heat waves. In 2003, for example, heat waves killed some 70,000 people all across Europe. Heat waves may also impact infrastructure, causing overheating and damage to installations of transport networks, changing the conditions for vehicles' road grip and affect the efficiency and output of energy infrastructure due to reduced availability of cooling water.[57] Northern countries are naturally less exposed to this threat than

[46] European Environment Agency, "Climate change, impacts and vulnerability in Europe", *Technical Report No. 12/2012*, 2012, 201-206, available at: http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012.
[47] EEA, 2010, *op.cit.,* 33-34. See also Barredo J.I., "No upward trend in normalised windstorm losses in Europe: 1970–2008", *Natural Hazards and Earth System Sciences*, 10, 2010, 97-104.
[48] COM(2013) 216 final, 16.4.2013, *op.cit.,* 2.
[49] European Commission, *Commission Green Paper On Forest Protection and Information in the EU: Preparing forests for climate change*, COM(2010) 66 final, Brussels, 1.3.2010.
[50] European Commission, *Proposal for a Directive of the European Parliament and of the Council establishing a framework for maritime spatial planning and integrated coastal management*, COM(2013) 133 final, Brussels, 12.3.2013.
[51] MOTIVE Project, http://www.motive-project.net/.
[52] MICORE Project, http://www.micore.eu/.
[53] PEARL Project, http://www.pearl-fp7.eu.
[54] RISC-KIT Project, http://www.risckit.eu.
[55] RISES-AM project, http://risesam.eu/.
[56] Quoted in EEA, 2010, *op.cit.,* 42.
[57] EEA, 2012, *op.cit.,* 201-206.

Southern nations. Climate change may however lead to an increase in the occurrence and intensity of heat waves in the future (see section 4).[58]

Droughts refer to precipitation shortfalls stretching over a prolonged period of time which may occur across all climates (different to aridity). These slow-onset phenomena have widespread impacts of extensive geographical scope. Droughts are usually classified in meteorological, agricultural, hydrological and socio-economic droughts, depending on their duration and principal impacts. Over the past two decades, the number of drought events in Europe has increased, potentially due to the effects of climate change causing rising temperatures, heat waves and dry winters. Regions of Europe with a moderate or high drought hazard are located in the Mediterranean, especially the Iberian Peninsula, Southern France, parts of Italy, Greece and Cyprus. However, to date no systematic drought risk assessments have been implemented at European level. So far, potential assessment possibilities and methodologies have been discussed at European level in the Water Scarcity and Drought Expert Group under the Common Implementation Strategy (CIS) for the Water Framework Directive (WFD). With the reform of the CIS this group has, however, disappeared and it is still to be decided which new working group should cover the topic. Drought hazards and risk assessments will be part of the River Basin Management Plans under the WFD.[59] In the meantime, the European Drought Observatory (EDO) has been producing data allowing for the JRC to provide initial estimates of drought hazards and projected changes across Europe (see map 3). These analyses will be refined and an analysis of the current and future hazard and risk for droughts and heat waves are included in the JRC work plan from 2014 to 2016.

Projects related to droughts are also being funded under the European Commission's FP7 programme such as the DEWFORA (Improved drought early warning and forecasting to strengthen preparedness and adaptation to droughts in Africa)[60] and DROUGHT-R&SPI (Fostering European drought research and science – Policy interfacing)[61] projects.

The issues related to droughts and water scarcity and the potential role of the EDO have been highlighted in the Communication on "Addressing the challenge of water scarcity and droughts in the European Union"[62] as well as in the European Parliament report "Towards a stronger European disaster response: the role of civil protection and humanitarian assistance"[63] and the Communication on "A Blueprint to Safeguard Europe's Water Resources"[64].

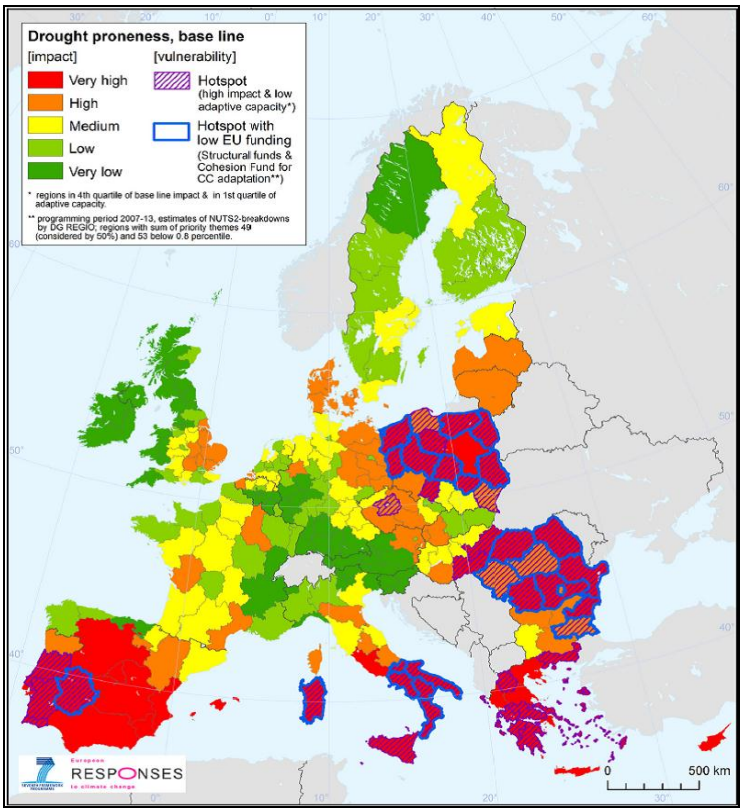
---

[58] COM(2013) 216 final, 16.4.2013, *op.cit.,* 2.
[59] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, *Official Journal of the European Communities*, L (327), 22.12.2000.
[60] DEWFORA Project, http://www.dewfora.net.
[61] DROUGHT-R&SPI, http://www.eu-drought.org/.
[62] European Commission, *Communication from the Commission to the European Parliament and the Council addressing the challenge of water scarcity and droughts in the European Union,* COM(2007) 414 final, Brussels, 18.7.2007.
[63] European Parliament, Committee on the Environment, Public Health and Food Safety, *Report on 'Towards a stronger European disaster response: the role of civil protection and humanitarian assistance',* A7-0283/2011, 19.7.2011.
[64] European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on a Blueprint to Safeguard Europe's Water Resources,* COM(2012) 673 final, Brussels, 14.11.2012.

One example of a sector specific policy at EU level which addresses such severe weather events, is the European Agricultural Fund for Rural Development (EAFRD)[65] which provides support for farmers to take preventive action against natural disasters, adverse climate events and catastrophic events as well as to support investment to restore the agricultural production potential damaged by these events. In order to get support, Member States and regions have to introduce this measure in their Rural Development Programmes.

Finally, the Commission Communication on an EU Strategy on adaptation to climate change refers to the increased frequency of extreme weather events, such as droughts in Southern and Central Europe (see section 4).[66]

Assessments of drought-proneness (see projected change from 2011 baseline to scenario 2041-70) at NUTS-2 level[67] have been undertaken also as part of the RESPONSES project (European responses to climate change: deep emissions reductions and mainstreaming of mitigation and adaptation)[68]. Projected changes in potential hotspots from different scenarios are indicated in the map that follows.



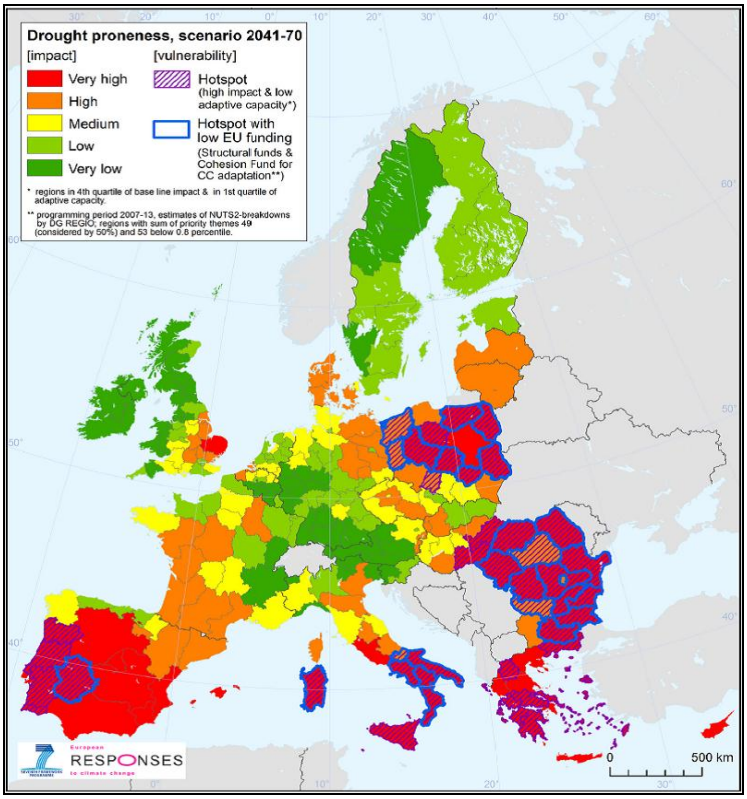
Map 3(a): drought proneness together with vulnerability hotspots at NUTS-2 administrative level for EU 27, baseline 2011

[65] Regulation (EU) 1305/2013 of the European Parliament and the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005, *Official Journal of the European Union*, L (347), 20.12.2013.

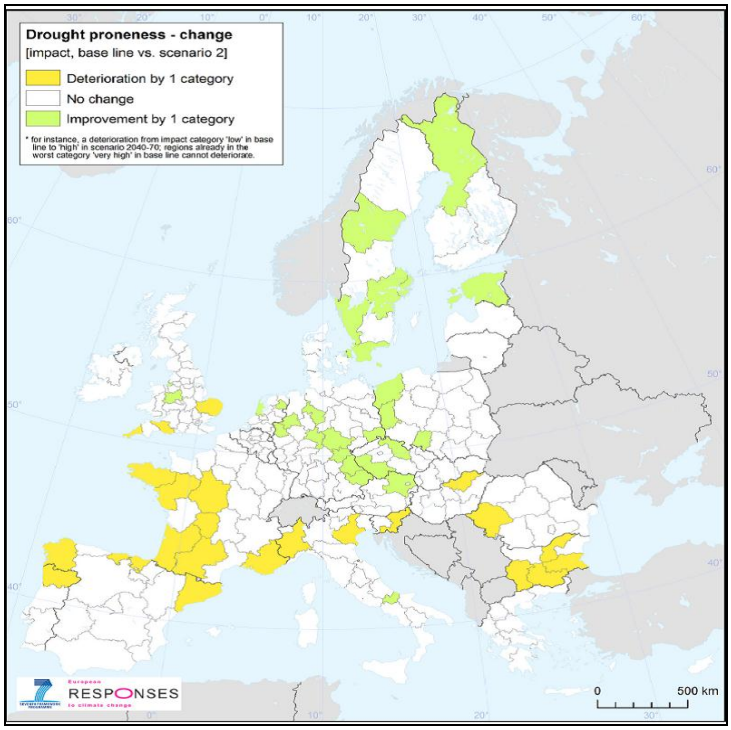
[66] COM(2013) 216 final, 16.4.2013, *op.cit.,* 2.

[67] see: http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction.

[68] RESPONSES Project, http://www.responseproject.eu/.



Map 3(b): drought proneness together with vulnerability hotspots at NUTS-2 administrative level for EU27, scenario 2041-70



Map 3(c): projected change in drought proneness from 2011 baseline to scenario 2041-70 on NUTS-2 administrative level for EU27

While heat waves have received much media attention, the risks of extreme low temperatures, or **cold spells**, are also high in Europe. No European definition exists of dangerously low temperatures, but these can be understood as periods of nine consecutive days during which temperatures reach -5°c or lower including six of those days during which the lowest temperatures reach -10°c or lower. In recent years, cold spells have had dramatic impacts affecting vulnerable populations and groups (elderly, children, homeless, and people with ischemic diseases, chronic respiratory diseases or asthma) with increased risk of mortality, as well as causing disruptions in services and

infrastructure (in transport infrastructure: signalling problems, damage to embankments, etc.[69]).[70] Section 4 explores the impact of climate change on extreme temperatures.

Heavy **snow** and/or **ice** can have both an economic and social impact on a country and/or region. Snow affecting large areas, that is, a number of counties or regions, or an entire part of the country, usually significantly reduces standard transport services. The cessation of transport services (restrictions/disruptions of train operations; road traffic safety issues such as increased risk of collision; risk of weather-related delays in all modes of services[71]) and associated disruption to healthcare services (increased demand and reduced ability to provide services) has both an economic and social impact. Other costs associated with ice or snow includes de-icing and salting of roads, repairs to roads and transmission cables. At the local level, there can be social disruption caused by transport delays, people being unable to go to work, strain on local services, power cuts, burst pipes, fatalities and injuries. In addtion, prolonged snow or ice has an impact on vulnerable groups such as the elderly or the homeless.

Heavy rainfall is a weather phenomenon directly linked with the flood hazard addressed above. Heavy precipitation over a short period of time can be the cause of particularly dangerous flash flooding. Heavy rain may also have other cascade effects such as landslides, loss/damage of critical infrastructure and transport accidents. In fact, the number of floods and heavy precipitation in Northern and North-eastern Europe has increased in recent years, in line with current projections of increased extreme events resulting from climate change as further discussed in section 4.[72]

Analysis of national risk assessments

The risk of severe weather hazards was identified by: Cyprus, Czech Republic, Denmark, Estonia, Germany, Hungary, Ireland, Lithuania, the Netherlands, Norway, Poland, Romania, Sweden, Slovenia, and the United Kingdom. While Greece and Italy do not focus on severe weather as such, their assessment of floods is closely related. This analysis will work with a definition of severe weather encompassing storms/hurricanes, heat waves, cold waves, droughts, snow and/or ice and heavy rainfall.

Storm hazards are extensively covered across most of the NRAs submitted, confirming the relevance of this risk for European countries. All but one (Romania) contributions have included storms in their list of identified risks: Czech Republic; Denmark; Estonia; Poland; Hungary; Ireland; Lithuania; the Netherlands; Germany; Norway; Sweden; Slovenia; and the United Kingdom. Storms often encompass a number of specific weather phenomena such as gale-strong winds, thunderstorms, and are linked to hurricane hazards. Results of national risk matrix assessments retrieved from risk matrices produced by Denmark, Estonia, the Netherlands, Ireland, Hungary and the United Kingdom identify storms as particularly high risk hazards. Storms are identified by Norway as the type of severe weather causing the most damage. In its scenario assessment, Lithuania points to the potential economic impacts of storms on electicity infrastructure, civil aviation and its environmental impacts. Denmark's analysis of

[69] EEA, 2012, *op.cit.,* 206.
[70] European Commission, Directorate General for Health and Consumers (DG SANCO), available at: http://ec.europa.eu/health/climate_change/policy/index_en.htm.
[71] EEA, 2012, *op.cit.,* 206.
[72] COM(2013) 216 final, 16.4.2013, *op.cit.,* 2.

historial evidence points to the cascade effect of storms on coastal flooding as a result of storm surges.

The risk of extreme hot temperatures and heat waves is considered by Ireland, Lithuania, the Netherlands, Germany, the United Kingdom, Estonia, Hungary and Sweden. With the exception of Hungary whose risk assessment focuses on the high level of impact of heat waves, all other Member States point to the high likelihood of occurrence of these events. In their analysis of a heat wave scenario, both the Netherlands and Sweden underline the high likelihood of occurrence of this hazard.

Closely linked with the occurrence of heat waves, drought is also addressed across half of assessments submitted: Germany, Ireland, Lithuania, the Netherlands, Norway, Poland, Romania, Slovenia and the United Kingdom. In fact, Ireland, Lithuania and the Netherlands combine droughts and heat waves under one hazard risk scenario. In its scenario analyses and risk assessments, Lithuania, Norway and Ireland underline the important environmental and socio-economic impacts of this hazard, particularly in the agricultural and energy sectors.

Across all national risk assessments analysed, the risk of extreme low temperatures is addressed in six European countries (United Kingdom, Germany, Ireland, Hungary, Estonia and Poland). Little information is provided on this specific risk, as this remains a hazard with relatively limited impact (Estonia, Ireland, United Kingdom) or low likelihood of occurence (Hungary). Ireland assesses low temperatures as a high likelihood event.

All the listed countries assess this risk together with the risk of snow/ice. In fact, the United Kingdom and Ireland address low temperatures and snow as one severe weather phenomenon. Lithuania and the Netherlands also consider snow and ice as a main hazard risk. No Southern European country has addressed this hazard, which would represent a low risk due to the very low likelihood of occurrence. The risk of heavy snowfall/ice is deemed to have both a relatively high impact and probability in the countries which identified snow and/or ice as a national risk. Most countries define heavy snowfall in terms of disruption to transportation services. The day-to-day impact of snow and ice on the individual and the state – through disruption to heating, transport, travel, etc. – can be significant. The residual impact is comparatively low. The UK estimates that periods of heavy snow can cost the economy £90 million (approximately €105 million) while Hungary estimates that annual damages from snow and ice repairs alone are between 15 to 20 billion HUF (approximately €59 million). The melting of snow and/or ice may increase the risks of other hazards such as forest fires due to longer dry periods (Hungary), flooding (Lithuania and The Netherlands), rockslides and landslides (Norway). Lithuania lists the sudden melting of snow or ice plugs as two of the five main causes of 'disaster floods' in the country.

Rainfall is only rarely addressed in the Member States' contributions. Only three Member States refer to this natural phenomenon: Denmark, Hungary, and Germany. Denmark's analysis of historical evidence confirms that heavy precipitation and cloudbursts have impacted the country most markedly in recent years, particularly in vulnerable urban areas. In fact, some cities have adopted comprehensive adaptation strategies or specific action plans (e.g. on risk prevention, flood or water management), or are in the process of doing so. Both Denmark and Hungary underline that likelihood of occurrence is high.

Overall, the cross-border dimension of severe weather events, affecting more than one country or region, is clear. All of the natural weather phenomena addressed cover large territories across national borders. In addition, as Lithuania indicates, the cascade effects of severe weather and ensuing cross-border risks must be taken into account.

Finally, more severe and frequent weather conditions in the future can be expected as a result of climate change. Denmark and Norway's assessments of storms, as well as Ireland and Sweden's assessments of droughts and heat waves confirm these worsening trends, which are further explored in section 4.

Map 4: Participating states assessing severe weather as a main risk hazard (DG ECHO, 2014)
(dark grey: participating states assessing hazard as a main risk; light grey: participating states not identifying this hazard in their submitted national risk assessments; white: countries for which no information is available)

2.3 Forest and wildfires

Forest and wildfires are a high probability risk and a recurrent phenomenon in the EU. Approximately 70,000 forest fires occur every year in the European Union, burning on average half a million hectares of forest and natural lands. Forest fires are an essential component of ecosystem dynamics; nevertheless, due to their growing intensity, recurrence and degree of impact, forest fires are considered a main natural hazard in Europe. The main direct effect of forest fires is the destruction of the natural landscape and the consequent loss of ecosystem constituents. Over 95% of fires are the consequence of malicious or unintended human action. Yearly economic losses due to forest fires are estimated at about €2 billion. In addition to ecological and economic losses, fires result in the loss of human lives every year. During the summer of 2007, forest fires in Greece alone claimed 80 lives among civilians and fire fighters.[73]

Forest fire hazards are not evenly distributed in Europe. The meteorological conditions under which forest fires take place determine their impact. Drought, high temperatures and strong winds facilitate fire ignition and spread. Since these conditions are found more frequently in Southern and South East European countries, these are the ones suffering most from the damages caused by fires, i.e. Bulgaria, Croatia, Cyprus, France, Greece, Italy, Romania, Portugal and Spain. Approximately, 85% of the total annual burnt area in Europe is located in five EU Mediterranean countries: Portugal, Spain,

[73] EEA, 2010, *op.cit.,* 47-48.

France, Italy and Greece. The forest fire season which affects Southern Europe every summer requires a large amount of both human and material resources such as fire-fighting planes and helicopters. In fact, the number of forest fires in Southern and Central Europe has increased in recent years, confirming projections of increased extreme events resulting from climate change as further discussed in section 4.[74]

While the EU Treaty makes no reference to specific provisions for an EU forest policy, the EU has a long history of contributing through its policies to implementing sustainable forest management and to Member States' decisions on forests. The Commission has recently adopted an EU Forest Strategy[75] that gives a new framework in response to the increasing demands put on forests and to significant societal and political changes that have affected forests over the last 15 years. Protection of forests from different threats, including fire is one of the priorities of this strategy, which also identifies prevention of fires as a key area for Member States to advance. Furthermore, the Forest Focus Regulation (EC) no. 2152/2003 provides for a Community scheme for a harmonised, long-term monitoring of the condition of forests, including forest fires. Created in 1998 by the JRC and the Commission Directorate General for Environment, the European Forest Fire Information System (EFFIS) is a comprehensive information source for fires across the EU[76]. Its role is to support the services in charge of the protection of forests against fires in the EU and neighbouring countries, while also providing the European Commission and Parliament with information on forest and wildfires in Europe.

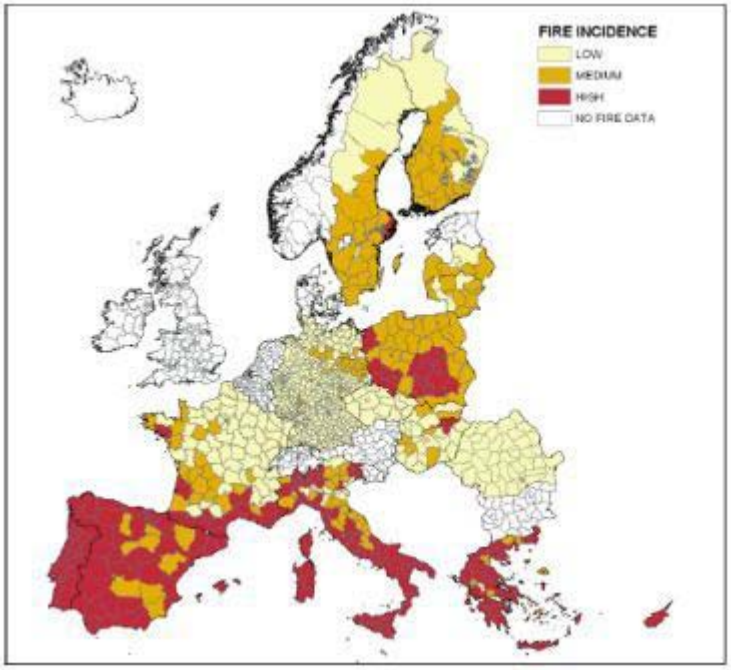
The European Agricultural Fund for Rural Development (EAFRD) provides support for forest fire prevention and restoration. In the framework of shared management, the Member States and regions can decide on how to use the EAFRD and on the priority they give to forest fire prevention and restoration actions. During the programming period 2007-2013 the five Mediterranean countries allocated more than €1.2 billion for measures targeting prevention and restoration of natural disasters and fires.

The Regulation on support for rural development[77] continues support for the period 2014-2020 for activities preventing and restoring damage to forests from fires and other natural disasters and catastrophic events including pests, diseases as well as climate change related events. Eligibility conditions and amounts available for such actions will be laid down in the new Rural Development Programmes of each Member State or region. Eligible operations shall be consistent with the forest protection plans established by the Member States. Support may also be provided for investments improving forest resilience and interventions concerning climate services[78].

Restoration measures following disastrous forest fires are also eligible for funding through the EU Solidarity Fund[79].

[74] COM(2013) 216 final, 16.4.2013, *op.cit.,* 2.
[75] European Commission, *Communication of the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on a new EU Forest Strategy: for forests and the forest-based sector,* COM(2013) 659 final, 20.9.2013.
[76] European Forest Fire Information System (EFFIS), http://forest.jrc.ec.europa.eu/effis/.
[77] Regulation (EU) No 1305/2013, 20.12.2013, *op.cit.,* 487.
[78] The MOTIVE project is an example of project investigating adaptive management strategies that address climate change and land use change: MOTIVE Project, http://motive-project.net/.
[79] Council Regulation (EC) No 2012/2002 of 11 November 2002 establishing the European Union Solidarity Fund, *Official Journal of the European Communities,* L (311), 14.11.2002.

It is possible to assess the incidence of forest fires on the basis of fire statistics from past years; this approach was used to derive the map presented in the figure below. In this figure, areas with high fire incidence are those in which the either the number of fires or the burnt area statistics in the past years were considered high or very high. A more complex methodology taking into account other fire related variables such as fuels, topography, etc. will lead to a comprehensive fire risk map at the European level.



Map 5: Forest fire incidence in Europe (JRC, 2012)

Analysis of national risk assessments

An analysis of the Member States' contributions identifies 11 Member States looking at the risk of forest and wildfires: Bulgaria, Cyprus, Greece, Hungary, Slovenia, Estonia, Poland, Romania, Germany, the United Kingdom and the Netherlands.

Forest and wild fires are a highly prominent hazard in Southern Europe. Fires are recurrent hazards during the summer season across Portugal, Spain, France, Italy, Greece and Cyprus. However, of the countries listed, only Greece has so far contributed to this overview. Further contributions may in the future address this hazard and contribute to this analysis.

Northern countries such as Estonia, Germany, Netherlands, Hungary and Poland have also identified wildfires and forest fires as a threat as one large forest fire regardless of the season may have bigger impacts than many small ones.

The main impacts of forest and wildfires are predominantly environmental but may also be human and socio-economic. According to the UK, wildfires can cause damage and disruption of transport systems and critical infrastructure (airports, power lines, etc.), businesses and private property; in fact, "*the impacts of wildfires will be most significant if they occur close to urban areas*"[80]. Notwithstanding the varying impacts highlighted across the relevant NRAs, all countries having submitted assessable data converge on the relatively high level of probability of occurrence of this hazard.

[80] UK Cabinet Office, 2013, *op.cit.,* 8.

The cross-border dimension of this hazard is underlined by Hungary. Indeed, fires are hazards which progress and affect areas irrespective of national boundaries. Greece also points to the regional dimension of this risk, stressing that all Southern European countries are particularly vulnerable to fires in the summer period.

Finally, the impact of climate change of the forest fire hazard is addressed by Hungary. The importance of forest and wildfires has increased in recent years, partly due to extreme weather conditions, low amounts of precipitation, high mean temperatures and low/no snow cover in recent winter seasons. This is further explored in section 4.

Map 6: Participating states assessing forest and wildfires as a main risk hazard (DG ECHO, 2014)
(dark grey: participating states assessing hazard as a main risk; light grey: participating states not identifying this hazard in their submitted national risk assessments; white: countries for which no information is available)

2.4 Earthquakes

Earthquakes are generally the result of a sudden subterranean release of energy due to an abrupt shift along a fault fracture. In fact, more than 90% of earthquakes are caused at plate boundaries. The main fault lines in Europe are where the Eurasian plate meets the African plate and runs through the Mediterranean Sea. Greece, Italy, Cyprus Portugal, Slovenia and Croatia as well as Romania and Bulgaria around the Black Sea are particularly at risk.

The JRC has been involved in earthquake risk science through various Units and actions, as well as through participation in FP7 projects such as Project Syner-G (Systemic Seismic Vulnerability and Risk Analysis for buildings, lifeline networks and infrastructure's Safety Gain)[81] and other scientific projects, including the GEM Project (Global Earthquake Model)[82]. The JRC is also running an operational earthquake impact assessment system in the framework of the Global Disaster Alert and Coordination System (GDACS)[83]. GDACS has collected earthquake data since 2003 in

[81] Syner-G Project, http://www.vce.at/SYNER-G/.
[82] GEM Project, http://www.globalquakemodel.org/.
[83] The GDACS is a cooperation framework between the UN, the European Commission and disaster managers worldwide to improve alerts, information exchange and coordination in the first phase after major sudden-onset disasters, http://www.gdacs.org/.

Europe and globally. The JRC tool RAPID-N, used for the risk assessment of NaTech risks at local and regional level, has also currently been implemented for earthquakes.[84]

The consequences of earthquake hazards are difficult to assess in a top-down approach. Earthquakes can trigger secondary effects (like landslides, floods caused by dam breaks, liquefaction, and tsunamis resulting from submarine quakes in sea basins such as the Atlantic west and the Mediterranean) and local amplification (local soil conditions that amplify the seismic motion and cause more destruction), for which local knowledge is necessary.

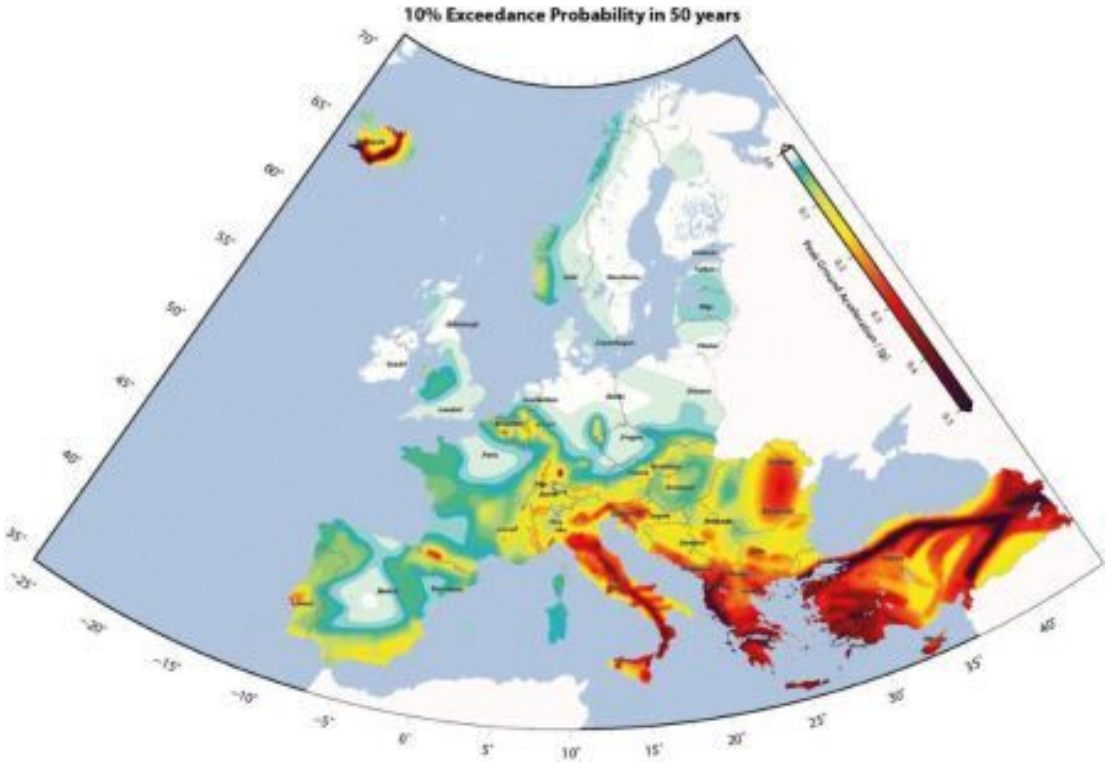
Furthermore, to assess the potential risk for infrastructure and population, local knowledge is required on vulnerability and exposure, including the location and structural characteristics of buildings, the applicable zonation and building codes, and the level of compliance with the codes. Vulnerability of the population should also be taken into account: for instance, socio-economic deprived populations, with worse housing conditions, might be expected to be more vulnerable.

Data is generally not available at national or European level, obliging top-down risk assessments to make assumptions and therefore making them less precise. However, they are useful tools to understand which regions are most at risk and which need to be encouraged to make more detailed risk assessments. Based on hazard data and overlaid with major cities (population 50000+), the JRC was able identify the top 20 European cities at risk from earthquakes (see annex 6). Furthermore, the European Commission is funding under its 7th Framework Programme projects on earthquakes such as the project SHARE (Seismic Hazard Assessment in Europe)[85], which provides the first complete seismic hazard model across Europe based on the most comprehensive databases of active faults, subduction zones, earthquakes, and strong-ground motion records. The reassessed combined model of earthquake occurrence, frequency and magnitude of future activity includes higher values of maximum magnitudes than previously estimated. The new reference European Seismic Hazard Map displays the ground shaking (i.e. Peak Ground Acceleration) to be reached or exceeded with a 10% probability in 50 years, corresponding to an average recurrence of such ground motions every 475 years, as prescribed by the national building codes in Europe for standard buildings; the values of expected ground shaking are in many areas higher than previously estimated, and reach over 0.5g ('g' standing for gravitational acceleration) in the areas of highest seismic activity. For the first time, SHARE computed for the whole European area also the higher ground shaking expected only every 1,000-5,000 years, of importance for the risk assessment and the protection of critical infrastructures such as dams or bridges considering the appropriate range of resonance periods. The new European seismic hazard model is the EU's contribution to the Global Earthquake Model (GEM) programme initiated by the OECD.

Other projects like Syner-G[86] explore new ways of assessing the systemic seismic vulnerabilities and related risks of building lifeline or built infrastructures, such as projects REAKT (Strategies and tools for Real Time Earthquake Risk Reduction)[87] that works on the improvement of forecasting, early warning and real-time risk reduction,

[84] Rapid NaTech Risk Assessment Tool (RAPID-N), http://rapidn.jrc.ec.europa.eu/.
[85] SHARE Project, http://www.share-eu.org/.
[86] Syner-G Project, *op.cit.*
[87] REAKT Project, http://www.reaktproject.eu/.

and NERA (Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation)[88].



Map 7: Earthquake hazard in Europe (FP7 Share project)

Analysis of national risk assessments

The following Member States have identified seismic hazards in their contributions to this overview: Bulgaria, Cyprus, Czech Republic, Germany, Greece (annex 7), Hungary, Italy (annex 8), Romania, and Slovenia.

All South-Eastern European countries underline the particularly high risk of this natural hazard. The human and socio-economic impacts of this hazard are of biggest concern. With its situation in the Eastern Mediterranean, Greece – along with neighbouring countries along the Mediterranean coast – is in a particularly high-risk area for earthquakes. Historical records show a number of major earth or seaquakes occurring there. A hazard map produced by Greece divides the country into three areas with different hazard levels (see annex 7). Italy is a country with high seismicity, characterised by regions where earthquake risk is of high likelihood and low impact (Vesuvius and Etna regions) as well as regions of low likelihood and high impact (Calabria Apennines, Eastern Sicily). Mortality rate due to earthquake hazards in Italy is 30,000 times more important than for any other natural hazard. Similarly, while overall seismic activity and related seismic risk in Hungary is medium, some regions such as Budapest-Kecskemét – one of the most active and highly populated – have a high seismic risk. Slovenia also identifies earthquakes as one of top two high risks.

By their very nature, earthquakes are unpredictable hazards that occur irrespective of national borders. The cross-border dimension of the earthquake risk is correlated to the exposure of areas along the fault lines in the Eastern Mediterranean and the Black Sea regions.

[88] NERA Project, http://www.nera-eu.org/.

Across all the Member States looking at earthquake risks, special attention is given to the need to reduce the growing vulnerability of communities to this hazard. Indeed, urban areas are developing in seismic areas, thus increasing the potential human and socio-economic impacts. All contributions address the importance of reducing the vulnerability of buildings, in line with the Eurocode 8[89] recommendations.

Map 8: Participating states assessing earthquakes as a main risk hazard (DG ECHO, 2014)
(dark grey: participating states assessing hazard as a main risk; light grey: participating states not identifying this hazard in their submitted national risk assessments; white: countries for which no information is available)

2.5 Pandemics/Epidemics

A **pandemic** or **epidemic** can have direct impacts on life, health and well-being, and severe indirect consequences in the form of socio-economic losses and strain on public health services and other areas of governance. HIV/AIDS is to date the most studied pandemic in history. NRAs addressing pandemic threats have focused on pandemic influenza, which has been of most relevance in recent years. While predictions over the timing and nature of future pandemic outbreaks are difficult, it is agreed that the most likely future pandemic will be due to a novel influenza-A virus. The immunity of the human population to new influenza viruses with pandemic potential is limited or absent. Influenza pandemics would primarily have impacts on human health, as well as incurring both direct and indirect economic costs.[90] Furthermore, people with chronic diseases can be more vulnerable to epidemic and pandemic hazards.

Three flu pandemics occurred worldwide in the 20th century. The Spanish flu killed over 20 million people between 1918 and 1919; the Asian flu killed over one million people between 1957 and 1958; the third flu pandemic occurred in Hong Kong in 1968-69 killing 800,000 people. Pandemics recur every 30-40 years following a variation in the virus' antigenetic structure, leading to the emergence of new Type A flu virus subtypes. The type A (H1N1) pandemic in 2009 was the first of the 21st century, which

[89] Eurocodes, EN 1998 Eurocode 8: Design of structures for earthquake resistance, http://eurocodes.jrc.ec.europa.eu/showpage.php?id=138.
[90] Organisation for Economic Co-operation and Development (OECD), "Future Global Shocks. Improving Risk Governance", *OECD Reviews of Risk Management Policies*, 2011, 29, available at: http://www.oecd.org/governance/48329024.pdf.

resulted in casualties in several countries and required responses at global, EU and national level.

Another example is the severe acute respiratory syndrome (SARS), a viral respiratory illness caused by a coronavirus, called SARS-associated coronavirus (SARS-CoV). SARS was first reported in Asia in February 2003. The illness spread to more than two dozen countries in North America, South America, Europe, and Asia before the SARS global outbreak of 2003 was contained. According to the World Health Organization (WHO), a total of 8,098 people worldwide became sick with SARS during the 2003 outbreak. Of these, 774 died. During the SARS event, tourist and transportation industries have been heavily impacted by the restriction of movements on a global level. The estimated income loss ranges from US$12.3-28.4 billion for East and Southeast Asia as a whole. [91]

Preparedness and response planning to mitigate or prevent the impacts of pandemics is carried out by Member States of the EU through pandemic preparedness plans, a number of which have been updated since the influenza pandemic of 2009. Strong action on health threats is already being taken at EU-level. The European Commission, the European Centre for Disease Prevention and Control (ECDC)[92] and the WHO Regional Office for Europe have since 2005 been providing assistance to the Member States.

The Commission through its Directorate General for Health & Consumers coordinates EU action in the field of preparedness and response planning for serious cross-border health threats[93]. It aims at strengthening capacities to respond rapidly to any kind of emergency affecting or likely to affect public health. This includes advising national authorities and ensuring that they take on board the EU dimension, considering that emergency planning at national level may also have an impact beyond borders. An EU-level strategy is under development to coordinate rapid risk assessments and scientific advice that can then feed into risk management decisions at EU-level. This strategy will also ensure the inter-operability of national plans through coordination mechanisms, analysis and communication tools.

EU research programmes[94] are tackling research preparedness for infectious disease outbreaks via on-going FP7 funded projects on emerging infectious diseases[95] where relevant clauses are included in the grant agreement, providing the possibility and obligation to change research priorities in case of an outbreak in order to ensure a rapid research response. Horizon 2020[96] also includes preparedness for new and emerging infections, including zoonosis as a priority: the first Horizon 2020 calls published in

[91] World Health Organisation, "Summary of probable SARS cases with onset of illness from 1 November2002 to 31 July 2003", *Global Alert and Response (GAR)*, 31.12.2003, available at: http://www.who.int/csr/sars/country/table2004_04_21/en/.
[92] European Centre for Disease Prevention and Control (ECDC), http://ecdc.europa.eu.
[93] DG SANCO, http://ec.europa.eu/dgs/health_consumer/index_en.htm.
[94] Directorate General for Research and Innovation (DG RTD), http://ec.europa.eu/research/index.cfm?pg=dg.
[95] PREPARE Project (Platform for European Preparedness Against (Re-)emerging Epidemics), website not yet established, but will be available soon; EMPERIE Project (European Management Platform for Emerging and Re-emerging Infectious Disease Entities), www.emperie.eu; PREDEMICS Project (Preparedness, Prediction and Prevention of Emerging Zoonotic Viruses with Pandemic Potential using Multidisciplinary Approaches), http://predemics.biomedtrain.eu; and the ANTIGONE Project (ANTIcipating the Global Onset of Novel Epidemics), www.antigonefp7.eu.
[96] Horizon 2020, EU Framework Programme for Research and Innovation (2014-2020), http://ec.europa.eu/programmes/horizon2020/en.

December 2013 include a call on the rapid identification of pathogens to improve the control of infectious epidemics and foodborne outbreaks. Finally, the initiative on Global Research Collaboration for Infectious Disease Preparedness (GloPID-R) launched in February 2013 together with the US, Canada, China, Australia, the United Kingdom, France and Sweden, aims to start an effective research response within 48 hours of a significant outbreak of a new or re-emerging epidemic. For this purpose the GloPID-R teams up funding bodies investing in research related to new or re-emerging infectious diseases with the objectives to strengthen the global research preparedness capacities by addressing the scientific, administrative and financial challenges which currently hamper international collaboration and a rapid response.

A recent Council and Parliament Decision addresses the important cross-border dimension of threats to health including threats of biological origin including communicable diseases, and chemical and environmental as well as unknown threats. In the case of influenza epidemics with pandemic potential or other serious events, the Commission may recognize a state of public health emergency.[97] The impact of climate change is of relevance to pandemic risk insofar that changes in temperatures and climate may affect the outbreak and spread of diseases (see section 4 on emerging risks).

Analysis of national risk assessments

13 Member States and Norway have identified pandemics and/or epidemics as a main risk hazard: Cyprus, Czech Republic, Denmark, Estonia, Germany, Ireland, Lithuania, the Netherlands, Norway, Poland, Romania, Slovenia, Sweden, and the United Kingdom. A distinction should be made between epidemics – more localised viral outbreaks – and pandemics – global scale outbreak. Member States tend to focus on an assessment of pandemics based on the greater severity and the geographical scope of this hazard.

Pandemics are considered one of the most severe threats with potential important human impacts on health and indirect socio-economic impacts as a consequence of the affected manpower running vital social and economic services. The recurrence of past pandemics suggests that this hazard may occur a few times a century, while more localised epidemics may occur more frequently. The overall uncertainty in measuring the level of impact and likelihood of pandemics make it a prominent hazard central to many NRAs.

Based on their assessment of pandemic scenarios, the United Kingdom and Norway assess influenza pandemics as posing the highest overall risk of all hazards addressed. Poland identifies pandemics as the second highest risk hazard and Estonia assesses this hazard in its top 'very high-risk emergencies' category, in both cases alongside floods. According to Denmark, unpredictability over the likelihood and impact of this hazard should grant it a prominent place in countries' priority ranking of hazards. In the case of Slovenia, while pandemics only rank as a medium overall risk, it is identified as one requiring considerable attention in future disaster risk management initiatives. In fact, an analysis of the few matrices provided suggests that, notwithstanding the scenario and assessment criteria and scales used, the risk level of pandemics is high to very high across all of the relevant Member States.

[97] Decision No 1082/2013/EU of the European Parliament and of the Council on serious cross-border threats to health and repealing Decision No 2119/98/EC, *Official Journal of the European Union*, L (293), 5.11.2013, article 12.

The cross-border nature of this threat is underlined by Member States. In its scenario assessment, Lithuania highlights the potential threat to third countries and neighbouring states in particular. Based on their scenario assessment, Estonia, the Netherlands, the United Kingdom and Denmark insist upon the cross-border dimension of this hazard by pointing to the high volatility and global nature of pandemics, accentuated by modern mobility beyond national borders.

Map 9: Participating states assessing epidemics/pandemics as a main risk hazard (DG ECHO, 2014)
(dark grey: participating states assessing hazard as a main risk; light grey: participating states not identifying this hazard in their submitted national risk assessments; white: countries for which no information is available)

2.6 Livestock epidemics/epizootics

The outbreak of illness among animal populations, particularly livestock, is also a major concern to countries in the EU. Animals and the foodstuffs production process 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. When a **livestock epidemic** spreads from animals to humans, this is called an **epizootic** or **zoonotic** development[98].

Some of the most severe epidemics include classic swine fever, avian influenza, foot-and-mouth disease, bluetongue, African Horse Sickness, Newcastle disease, West Nile virus and rabies. Animal diseases can be distinguished in two categories: non-zoonotic diseases, which are limited to infection amongst animals and zoonotic diseases which are transmissible to humans. Non-zoonotic diseases, include foot-and-mouth (a highly-contagious viral infection affecting all ruminants and pigs), classical swine fever (a viral infection affecting swine), bluetongue (a viral infection affecting ruminants sheep) and African Horse Sickness (a disease affecting horses transmitted by insects). Zoonotic diseases include: the highly pathogenic avian influenza HPAI (a viral infection of the influenza-A virus affecting birds), rabies (a fatal viral infection affecting the nervous system of mammals – the most recent form is present in bat populations), and the West Nile virus (a viral infection of birds, horses and humans spread by mosquitos).

[98] Definitions may vary when translated.

All of these diseases are classified by the World Organisation for Animal Health (OIE)[99] as 'list A' diseases, meaning that they are fast spreading diseases of major economic importance[100]. Indeed, such epidemics can result in substantial losses for governments, farmers and all other stakeholders involved in the livestock production chain. In countries with a highly industrialised agricultural sector, vulnerability to the spread of such diseases is particularly high. In addition, epizootic/zoonotic developments may also have serious human impacts on health.

Other serious forms of epidemics include those affecting farmed fish and shellfish in aquaculture, as well as outbreaks of organisms affecting the wider natural ecosystem, with harmful effects on the economy and possibly human life (toxic algae, jellyfish).

Similarly to pandemics, the impact of climate change is of relevance to livestock epidemic risk insofar that changes in temperatures and climate may affect the outbreak and spread of diseases (see section 4 on emerging risks).

EU legislation to control avian influenza is laid out in Directive 92/40/EEC, which requires the investigation of suspected cases of avian flu, as well as the humane killing of infected poultry and of feeding stuffs/equipment/manure as a means of limiting the spread of the disease[101]. Directive 2000/75/EC lays out the control rules and measures to fight bluetongue, establishing surveillance zones and possible bans on susceptible animals leaving these areas[102]. Swine fever control measures are laid out in Directive 2001/89/EC: in the case of an outbreak, all pigs of infected farms must be put down and cadavers destroyed; protection and surveillance zones must be put in place[103]. Measures to be taken to combat African Horse Sickness are laid out in Directive 92/35/EEC[104]. EU control measures for foot-and-mouth disease are laid out in Directive 2003/85/EC aiming at regaining the disease infected-free status of the territory in question[105]. For foot-and-mouth disease provisions are also made for the use of emergency vaccination. As a result, the EU has the biggest antigen bank worldwide for express vaccine formulations.

Analysis of national risk assessments

The risk of livestock epidemics is identified by 12 Member States: Czech Republic, Denmark, Estonia, Germany, Hungary, Ireland, Lithuania, Poland, Romania, Slovenia, Sweden and the United Kingdom. Terminology used by Member States includes: livestock epidemics; epizootic/zoonotic; animal diseases. In some cases, distinction is made between epizootic and non-epizootic diseases (Denmark; Lithuania; United

[99] Formerly known as the Office International des Epizooties, see: http://www.oie.int/.
[100] The list of 'list A' diseases is available at: http://www.oie.int/en/animal-health-in-the-world/the-world-animal-health-information-system/old-classification-of-diseases-notifiable-to-the-oie-list-a/.
[101] Council Directive 2005/94/EC of 20 December 2005 on Community measures for the control of avian influenza and repealing Directive 92/40/EEC, *Official Journal of the European Union*, L (167), 14.1.2006.
[102] Council Directive 2000/75/EC of 20 November 2000 laying down specific provisions for the control and eradication of bluetongue, *Official Journal of the European Communities*, L (327), 22.12.2000.
[103] Council Directive 2001/89/EC of 23 October 2001 on Community measures for the control of classical swine fever, *Official Journal of the European Communities*, L (316), 1.12.2001.
[104] Council Directive 92/35/EEC of 29 April 1992 laying down control rules and measures to combat African horse sickness, *Official Journal of the European Communities,* L (157), 10.6.1992.
[105] Council 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, *Official Journal of the European Communities,* L (306), 22.11.2003.

Kingdom). In this overview, livestock epidemics combine both epizootic and non-epizootic developments.

Member States point to the potential socio-economic and human impacts of this hazard. All countries having assessed this risk scenario stress the impact on the production and trade of food products (poultry, meat) and the potential human impact through health risks associated with epizootics (Denmark, Ireland, Lithuania and the United Kingdom). In addition, Ireland points to the potential impact on tourism as a result of restricted access to country-side areas.

Results gathered from national risk matrices suggest that the risk of livestock epidemics is considered relatively low compared to similar hazards such as human-to-human transmissible pandemics. With the exception of Lithuania, all countries analysed ranked the probability of occurrence of a livestock epidemic as moderate and below, which remains a comparatively low score compared to other hazards assessed.

Livestock epidemics and epizootics have a clear cross-border dimension as the spread of the virus to neighbouring countries is possible due to the fast spread of viruses and global wild fauna migration irrespective of national borders. The cross-border dimension of this risk is addressed by Denmark, Ireland, Lithuania and the United Kingdom. In particular, Lithuania presents a scenario addressing the impact of migrating wild fauna in the Nemunas Delta, a well-studied passage for migrating birds along the Baltic coast, where birds infected with High Pathogenic Avian Influenza will increase the likelihood of viral infections in the area.

In identifying the possible future trends of this hazard, Denmark warns that climate change and global warming may increase the risk of livestock epidemic epizootic outbreaks as a result of changing geographical distribution of wild animals and varying migratory routes. Rising temperatures may also lead to the appearance of new fertile environments for diseases so far considered exotic in Europe. The impact of climate change as an emerging risk is further developed in section 4.

Map 10: Participating states assessing livestock epidemics as a main risk hazard (DG ECHO, 2014)
(dark grey: participating states assessing hazard as a main risk; light grey: participating states not identifying this hazard in their submitted national risk assessments; white: countries for which no information is available)

3 MAN-MADE NON-MALICIOUS DISASTER RISKS

3.1 Industrial accidents

Establishments where significant[106] quantities of dangerous substances are handled or stored represent a major source of **industrial accident** risk for human populations and the environment. Substances may be considered dangerous because of health hazards (e.g. acute toxic substances), physical hazards (e.g. explosives, highly flammable substances) or environmental hazards. It is of great importance to understand the hazards involved in the activities of the establishments handling such substances, and to keep information and maps that illustrate the possible consequences of any accident that could happen at relevant establishments. Types of industry covered in this category include chemical installations, fuel storage, chemicals manufacture, general engineering, liquefied natural gas (LNG) production, storage and distribution, cement lime or plaster manufacture, processing of metals, production of pharmaceuticals, waste treatment etc..

The 'Seveso' Directive on the control of major accident hazards involving dangerous substances sets a European framework for the prevention of, preparedness for and response to industrial accidents[107]. The Seveso Directive obliges Member States to ensure that operators have a policy in place to prevent major accidents. Operators handling dangerous substances above certain thresholds must notify their activities to the relevant national competent authorities, submit safety reports, establish a safety management system and set up an internal emergency plan. Member States shall ensure that the public likely to be affected by an industrial accident is regularly informed and that relevant information is kept permanently available for the public, also electronically. National competent authorities must ensure that external emergency plans are in place for the surrounding areas and that mitigation actions are planned. Regular inspections must take place. Account must also be taken of the objectives of prevention and control of major-accident hazards in land-use planning. There is a tiered approach to the level of controls: the larger the quantities of dangerous substances present within an establishment, the stricter the rules ('upper-tier' establishments have bigger quantities than 'lower-tier' establishments and are therefore subject to tighter control).

The 'Environmental Liability Directive' (ELD) aims at preventing and remedying environmental damage, defined as damage to biodiversity, water and land, based on the polluter-pays principle[108]. The Directive establishes strict liability for operators carrying out certain hazardous activities (chemical industry and other 'big' industry, carbon capture and storage (CCS) installations, waste management including shipment of waste and mining waste, water related activities, handling, use, manufacture of dangerous substances, preparations or biocides, transport of dangerous substances, Genetically modified organism (GMO)-related activities, offshore oil and gas activities etc.). They are obliged to take preventive action in case of imminent threat of environmental

[106] A quantity that is significant depends on the potency and type of hazardous property of the substance.
[107] Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances, *Official Journal of the European Communities*, L (10), 14.1.1997,13, which will be replaced, as of 1 June 2015, by Directive 2012/18/EU of the European Parliament and of the Council on the control of major-accident hazards involving dangerous substances, *Official Journal of the European Union*, L (197), 24.7.2012, 1.
[108] Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage, Official Journal of the European Union, L (143), 30.4.2004, 56.

damage and to take remedial action in case of damage to the above indicated natural resources and their services (restore them to their baseline condition). The ELD does not establish remediation for traditional damage (damage to property, personal injury/health damage, economic loss). The Directive is supposed to create a deterrent effect on operators, inducing them to operate their activity safely, inter alia by carrying out risk assessments. The ELD does however not establish mandatory financial security at EU level but leaves this decision up to the Member States (eight have decided to introduce mandatory systems: Spain, Portugal, Czech Republic, Slovakia, Hungary, Bulgaria, Romania and Greece).

Accidental releases involving dangerous substances in chemical installations, petrochemical and oil refineries happen frequently in Europe and demonstrate the need for better and more efficient control of major industrial hazards. Industrial accident prevention and preparedness in Europe is aimed not only at preventing major catastrophes, such as the fire in the petroleum storage depot at Buncefield (United Kingdom, 2005) or the ammonium nitrate explosion in Toulouse (France, 2001), but also at smaller incidents that violate the right to a safe community, a safe workplace and a clean environment. Figure 1 below shows the number of major accidents in EU, European Economic Area (EEA) and European Free Trade Association (EFTA) countries from 2001 – 2011.[109]

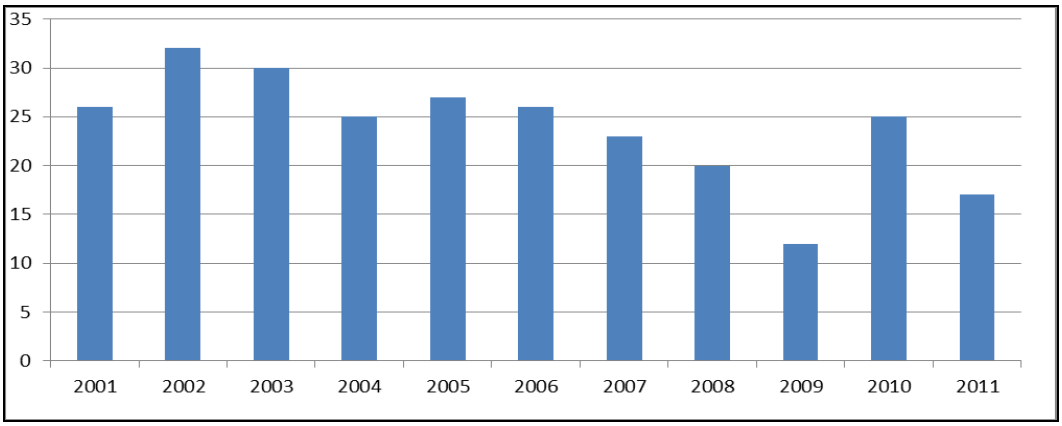
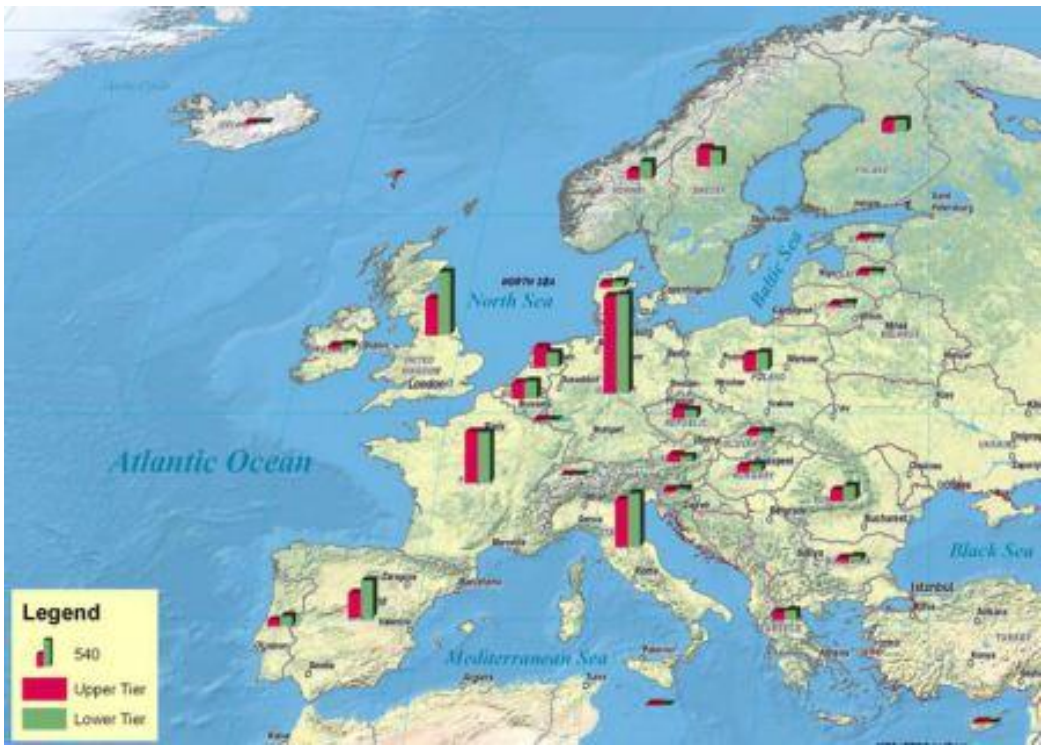


Figure 2: Number of Major Accidents in the eMARS database from 2001 – 2011 (JRC, 2012)

The number of Seveso establishments per country is illustrated in Map 11 below (see ranked order in Annex 9). At the end of 2012, there were 9,778 Seveso establishments in Europe. Of the total EU/EEA establishments, approximately 47% had upper tier status and 53% lower tier status in 2012. Typically, the most industrialised countries have the most establishments. Together, Germany, France, Italy and the United Kingdom account for more than half (55%) of total Seveso establishments in Europe.

[109] In accordance with the Seveso II Directive (96/82/EC) for the control of major hazards involving dangerous substances, Member States must report all major chemical accidents occurring in Seveso establishments to the European Commission. These accident reports are available to the public online at https://emars.jrc.ec.europa.eu.



Map 11: number of Seveso establishments in EEA countries (JRC, 2012)

Analysis of national risk assessments

14 Member States and Norway have identified industrial/chemical accidents in their national risk assessments, six of which using a risk matrix: Czech Republic, Denmark, Estonia, Germany, Greece, Hungary, Ireland, Lithuania, the Netherlands, Norway, Poland, Romania, Slovenia, Sweden and the United Kingdom. Analysis of this hazard in this overview regroups industrial accidents, chemical and hazardous material (hazmat) accidents. Member States also refer to chemical contamination (Poland, Sweden), hazardous industrial accidents (Hungary, Norway), the release of chemical substances (Germany) and accidents with dangerous substances (Denmark). While 'dangerous substances' generally refer to an array of chemical, biological, radiological and nuclear substances, this section will concentrate on chemical substances, while radiological and nuclear accidents will be discussed in a later section of this overview.

The main consequences of industrial and chemical accidents identified in the NRAs are: human, due to risks of fire, explosion, and contamination; environmental, due to the risk of water and ground contamination; and economic, due to the damage and repair costs incurred and the cascading effect on surrounding economic activity.

According to the results of Member States' risk assessments, the risk of major industrial or chemical accident scenarios is considered relatively low, due to high levels of regulation and control measures in place (United Kingdom, Denmark), to the national phasing out of highly dangerous substances (Denmark) and, in some cases, to few existing lower and upper tier Seveso sites domestically (Ireland). Notwithstanding, while other hazards may supersede industrial accidents in their assessed level of risk (for example, in Greece these accidents are considered much less frequent than earthquakes and wildfire), Member States insist that the risk of industrial accidents cannot be underestimated (Greece; United Kingdom; Denmark; Ireland). This is particularly the case as many industrial and chemical sites may be located in close proximity to local communities (United Kingdom; Ireland; Lithuania; Norway).

The cross-border dimension of this risk is relevant insofar those industrial and chemical accidents may lead to the spreading of chemicals in the air or water (Lithuania). The risk of chemical accidents may also be the result of a transport accident in the import of dangerous chemical substances from neighbouring countries (Denmark).

Finally, Denmark's risk assessment addresses the link between climate change and industrial/chemical accidents, pointing to growing risks of extreme weather exposing chemical plants to increased risks of damage/disruption.

Map 12: Participating states assessing industrial/chemical accidents as a main risk hazard (DG ECHO, 2014)
(dark grey: participating states assessing hazard as a main risk; light grey: participating states not identifying this hazard in their submitted national risk assessments; white: countries for which no information is available)

3.2 Nuclear/radiological accidents

As defined by the International Atomic Energy Agency (IAEA), a **nuclear or radiological accident** corresponds to "*any accident involving facilities or activities from which a release of radiological material occurs or is likely to occur and which has resulted or may result in an international trans-boundary release that could be of radiological safety significance for another state*".[110]

There are currently 131 nuclear reactors in operation in the EU, grouped on 56 sites in 14 Member States. Their safety record is such that although "incidents" have occurred and continue to occur, no "major accidents" have ever taken place[111]. In general nuclear accidents correspond to low probability/high impact type of risks, with potentially high human, economic and environmental (marine and inland) impacts. Due to the high potential impact of any nuclear accident, nuclear power plants are subject to strict safety and security controls and national authorities have strict prevention and mitigation measures in place.

Following the accident at the Fukushima reactors (Japan) in March 2011, it was agreed that all nuclear power plants in the EU should be reviewed by independent parties by

[110] International Atomic Energy Agency (IAEA), *IAEA Safety Glossary*, 2007, 12, available at: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1290_web.pdf.
[111] 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.

undergoing a comprehensive and transparent risk and safety assessment, also known as 'stress tests'. These 2011-12 stress tests re-assessed the safety margins of the EU power plants against the impacts from extreme external events, such as earthquakes and flooding. The first findings of the stress tests were published in a Commission Communication[112] and were followed on the technical level by the adoption of the European Nuclear Safety Regulators Group (ENSREG) stress test report with a large number of recommendations for technical improvements at all nuclear power plants in all participating countries[113] and on the political level by a second Commission Communication[114] including an agreement to pursue further examinations.

After the Fukushima accidents, the nuclear fission energy area of the Framework Programme of the European Atomic Energy Community (Euratom) for nuclear research and training activities[115] was re-oriented towards more safety research of existing reactors (accident prevention, probability risk assessment, severe accident management, plant life management). In the field of radiation protection, research is focused on better understanding the risks arising from low dose of radiation and long term exposures such as those occurring after a nuclear accident for the most exposed population. Better scientific knowledge in this field will help reduce uncertainties that are the source of increasing costs of countermeasures after an accident.

Analysis of national risk assessments

12 Member States and Norway identify the risk of nuclear and/or radiological accidents: Bulgaria, Czech Republic, Denmark, Estonia, Germany, Ireland, Lithuania, the Netherlands, Norway, Poland, Romania, Slovenia and Sweden. Ireland and Sweden distinguish nuclear and radiological accidents, while both indicate nuclear accident as a hazard originating abroad. Germany addresses the threat of 'release of radioactive substances' including the threat of nuclear/radiological accidents as well as other forms of radioactive release.

National assessments attributed the limited likelihood of such hazard occurring, in part due to the high level of technical standards, organisation, authority control and safety culture. In terms of impact, however, there is a shared view that the human, environmental and economic impacts of a nuclear accident could be very severe, involving land/water contamination, longer-term health complications due to exposure to radiation (cancers) or psychological stress and important economic costs due to losses in the agricultural sector, reduced tourism and affected industrial production.

An analysis of risk matrices in national assessments received confirms the high impact/low probability risk of nuclear accidents through clear differences in the scores

[112] European Commission, *Communication from the Commission to the Council and the European Parliament on the interim report on the comprehensive risk and safety assessments ("stress tests") of nuclear power plants in the European Union*, COM(2011) 784 final, Brussels, 24.11.2011.
[113] European Nuclear Safety Regulators Group, *Peer review report: Stress tests performed on European nuclear power plants*, 2012, available at: http://www.ensreg.eu/sites/default/files/EU%20Stress%20Test%20Peer%20Review%20Final%20Report_0.pdf.
[114] European Commission, *Communication from the Commission to the Council and the European Parliament on the comprehensive risk and safety assessments ("stress tests") of nuclear power plants in the European Union and related activities*, COM(2012) 571 final, Brussels, 4.10.2012.
[115] Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Seventh Framework Programme of the European Community for Research, technological development and demonstration activities (2007-2013), *Official Journal of the European Union,* L (412), 30.12.2006.

allocated for impact and those for likelihood of occurrence: the probability of occurrence of a nuclear accident obtains low to very low scores across the matrix assessments submitted. Comparatively, impact ratings are much higher.

The cross-border dimension of this hazard is underlined by Denmark, Estonia, Ireland, Lithuania and Norway. The spreading of radiation in the air, the contamination of the environment and the economic impacts will affect both the country in which the nuclear accident occurs and neighbouring countries. In fact, Ireland identifies the threat of a nuclear accident as an external risk – distinctive from a domestic radiological incident –, Norway stressed that it is "surrounded" by countries with some form of nuclear activity, and Lithuania breaks down its scenario analysis into the internal and external dimension of the threat.

Map 13: Participating states assessing nuclear/radiological accidents as a main risk hazard (DG ECHO, 2014)
(dark grey: participating states assessing hazard as a main risk; light grey: participating states not identifying this hazard in their submitted national risk assessments; white: countries for which no information is available)

3.3 Major transport accidents

Transport accidents refer to maritime, air and land accidents involving the transport of people, goods or services. Transport accidents can be caused both intentionally (e.g. terrorist act) or unintentionally. Most common are transport accidents related to technical or mechanical failures or involving human factors.

Maritime transport constitutes a complex network posing several challenges from a safety, environmental and security standpoint. The sector, with many elements of critical infrastructure, needs a comprehensive approach in assessing associated risk landscape with quantitative risk analysis. From a risk analysis perspective, the maritime transport is a network of maritime operations that interface with shore-side operations at intermodal connections as part of the overall European supply chains or domestic commercial operations. The networks have components that include vessels, port facilities, waterways and waterway infrastructure, and intermodal connections and users, including crew, passengers, and navigation infrastructure and services. With regards vessels, risk factors should be associated with events such as on board fire, collision with another vessel, explosion, sinking, grounding and contact with an industrial fixed structure. In the case of cargo, oil and gas transport by sea poses both safety and environmental challenges. Hazards include wasting oil and gas, injuries, ship

and property damage and environmental degradation. Maritime transportation of dangerous goods and related hazards has become some of the most important issues in transportation and environmental discussions. In addition, most major ports, which are no longer restricted to industrial areas due to urban development, are located next to volatile maritime infrastructure that could lead to mass conflagration as a result of a natural event or man-made intentional attack. These risks could have environmental impacts on much larger areas due to toxic gas releases.

Transport accidents in the aviation sector can occur anywhere but are more likely near or at aerodromes. Large aircraft commercial air transport accidents are rare but can have significant consequences. Catastrophic accidents can mean large numbers of lives are lost in one event. In terms of numbers of fatalities losses of control and flight into terrain represent the biggest threats. In 1977, the Tenerife disaster, a fatal collision between two Boeing 747 passenger aircrafts on the Spanish island, resulted in a total of 583 fatalities, and remains the deadliest civil accident to date. In addition, security events (hijacking and terrorist acts) can result in catastrophic accidents.

Land transport accidents may occur on railways or roads and on/in related infrastructure such as bridges, tunnels, stations, stopping-places, freight terminals, etc. Transport accidents in the railway sector include collisions between trains running on the same track or changing tracks; failure of the railway infrastructure (track, bridges, embankments, etc.) or train control system causing derailment or collision. Transport accidents in the road sector can occur through collisions between buses, heavy goods vehicles, cars, etc. and in connection with road works. The most common transport accidents are road traffic crashes, accounting for around 26 000 fatalities in 2013 and many more serious injuries, at large cost to society. In the case of severe weather scenarios but notably for storms, heat, snow/ice and heavy rainfall, the risk of road traffic crashes increases substantially because of reduced visibility, slippery road surfaces or winds affecting the vehicle's direction of movement. The risks can be reduced by properly sensitising road users to the need to adapt speed and driving behaviour to the road conditions. Both for road and railway sectors, accidents in tunnels, on bridges or in areas with limited possibilities of evacuation can constitute a special risk, especially if combined with the risk of explosion of dangerous goods and/or the risk of on-board fire. The Mont Blanc tunnel accident of 1999 resulted both in immediate human casualties and long-term economic and social disruptions due to its ensuing closure for 3 years. In the rail sector, accident rates have been showing a consistent improvement year on year, although in 2013, major derailments occurred in Bretigny-sur-Orge, France, and in Galicia, Spain.

Finally, in agreement with Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods, competent Authorities of the Member States may impose restrictions on transport of dangerous goods. However, the restrictions imposed on one transport mode may just lead to transfer of the risk to other transport mode or to alternative routes in neighbouring countries. In some cases, the overall result may be an increase of risk to the public (e.g. if the alternative transport mode is less safe or if the alternative route is much longer). This transfer of risk should be taken into account in the assessment carried out by the competent Authority deciding the restriction.

Analysis of national risk assessments

10 contributions address the risk of transport accidents: Estonia, Denmark, Hungary, Ireland, Lithuania, the Netherlands, Norway, Slovenia, Sweden, and the United Kingdom. The types of transport accidents assessed include maritime, aircraft and land (rail & road), as well as the transport across all types of sectors of hazardous materials.

Despite an increase in the volume and intensity of traffic across all three transport sectors, which would in principle increase the probability of occurrence of major transport accidents, higher safety standards, greater regulation and control measures have in fact brought about a reduction of major accidents in recent years. All assessments underline the need to look at transport accident risks due to their potentially severe human, economic and environmental impacts.

Maritime transport accidents are granted particular attention across the NRAs. As the below map illustrates, most of the countries addressing this hazard have coastal borders. Lithuania, Sweden and Norway only address maritime accidents, while Estonia and Ireland assess the risk of maritime transport accidents higher than for other forms of transport. Maritime transport accidents involving cruise ships, containers and tankers tend to present high risk due to the severity of their human, economic and environmental impacts. Through different scenarios, Estonia, Norway and Lithuania focus on the environmental impacts of maritime accidents. Sweden's scenario involving the contamination of waterworks highlight the human impact of these accidents; Norway and Denmark underline the risk of high number of casualties resulting from a maritime accident.

Aircraft accidents may result in high human impact of numerous casualties as is identified by Denmark, Ireland and the United Kingdom. Land transport accidents – rail and road – are generally considered of lower risk for the very low number of accidents requiring an emergency response at a national scale, combined with improved technical and safety standards across all the transport sectors (Denmark, Ireland, Norway and the United Kingdom).

Of relevance to all forms of transport accidents, however, is the risk of accidents in the transport of hazardous material (hazmat)[116]. This risk is generally addressed alongside industrial accidents (Denmark, Norway, Sweden, and United Kingdom). The causes of such accidents are those relevant to any transport accident, but the consequences due to spillage, fires and explosions of these substances will resemble those of chemical accidents identified in the above section, affecting health, property and the environment.

The cross-border dimension of this hazard is rarely referred to in national assessments, but its relevance is clear. As Lithuania concludes from its scenario analysis, the spillage of fuel or hazardous substances resulting from a major maritime transport accident may affect waters and coastlines of neighbouring countries.

Finally, the cascade effect of increased extreme weather conditions resulting from climate change on transport accidents is briefly mentioned in Denmark's assessment.

[116] This hazard may also be associated with the risk of industrial/chemical accidents.

Map 14: Participating states assessing transport accidents as a main risk hazard (DG ECHO, 2014)
(dark grey: participating states assessing hazard as a main risk; light grey: participating states not identifying this hazard in their submitted national risk assessments; white: countries for which no information is available)

3.4 Loss of critical infrastructure

The potential for loss of critical infrastructure has been specifically identified as a cascade effect of most of the other risks addressed in this review. There is also an additional risk of direct malicious and non-malicious interference to the normal operation of critical infrastructure.

The impacts arising from a loss of critical infrastructure, are the disruption to, or complete cessation of, the delivery of essential services to large sections of the public. Essential services include the provision of energy, water, food, communications, health and emergency response services, transport and finance. The effects on citizens arising from disruption or cessation of any of these essential services will depend on the duration of the disruption, the time of year, the resilience of the service, and the response by the authorities, but will probably involve a societal effect, economic consequences, and in extreme cases casualties.[117]

In 2006 a major electricity blackout occurred, which affected 15 million households for about two hours. The initial cause was a routine disconnection of a power line crossing in Germany to allow a ship to pass beneath the overhead cables. However, as a result of insufficient communication between the operators, unexpected load flows resulted in the loss of a key distribution interconnector. Within seconds, an electrical blackout had cascaded across Europe, including Poland, the Benelux countries, France, Portugal, Spain, Morocco, Greece and the Balkans.

In 2003, storms caused a cross-border blackout when the power line which supplied electricity to Italy from Switzerland was damaged, causing it to trip out. The cascading effect disrupted power supply to Italy from France and Switzerland. The cascading effect on power lines blacked out nearly all of Italy for 12 hours and part of Switzerland for 3 hours, affecting a total of 56 million people. Hundreds were trapped in

[117] European Commission, Directorate General for Home Affairs (DG HOME), available at: http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/crisis-and-terrorism/critical-infrastructure/index_en.htm.

underground trains. 110 mainline trains were cancelled, with 30,000 people stranded on trains. All flights in Italy were also cancelled; many people spent the night sleeping in train stations, and on the streets in Rome.

Critical infrastructures are complex interconnected systems that are subject to a wide range of risks and hazards, are interdependent and can extend well beyond the geographical and jurisdiction limits of one Member State. To this end, achieving a harmonised risk assessment and risk management approach is important (for all previously mentioned reasons, such as comparability of risks) yet a lot remains to be done.

The European Programme for Critical Infrastructure Protection (EPCIP)[118] contributed extensively to improving the collaboration of Member States towards this objective. EPCIP has several elements among which a legislative one, the Council Directive 2008/114/EC setting out to create a procedure for the identification and designation of critical infrastructures[119], and a common approach to the assessment of the improvements needs in the protection of such critical infrastructures.[120] The revised EPCIP has taken a much more pragmatic spin fostering the implementation of elements of risk assessment and risk management focusing on real case studies of infrastructures of European dimension.[121]

The elements of risk assessment and the corresponding methodologies are explicitly mentioned in the Directive text[122]. This demonstrates the importance of risk assessment for critical infrastructures at European level. Actually no harmonized methodology exists and Member States are following their own respective methodologies making the comparison and communication of risks a cumbersome process. The Joint Research Centre is actively supporting this by providing tools and methodologies to be implemented on these case studies.

The JRC has implemented the European Reference Network for Critical Infrastructure Protection (ERNCIP)[123], comprising over 200 active CIP experts from across the EU, focussing on technological security solutions for protection of critical infrastructures. The Commission has also funded a number of projects relevant to risk assessment and risk management under the 'Prevention, Preparedness and Consequence Management of Terrorism and other Security Related Risks' (CIPS) Programme between 2007 and 2013[124]; these include: the development of a methodology for risk assessment for enhancing security awareness in air traffic management[125]; the assessment of resilience to threats to systems of data and control management of electrical transmission

[118] European Commission, *Communication from the Commission on a European Programme for Critical Infrastructure Protection (EPCIP)*, COM(2006) 786 final, Brussels, 12.12.2006.
[119] European Critical Infrastructure (ECI) is an asset or system which is essential for the maintenance of vital societal functions. The damage, disruption or destruction of critical infrastructure may have significant impacts for the well-being and security of the EU and its citizens.
[120] 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, *Official Journal of the European Union*, L (345), 23.12.2008.
[121] European Commission, *Commission Staff Working Document on a new approach to the European Programme for Critical Infrastructure Protection Making European Critical Infrastructures more secure*, SWD(2013) 318 final, Brussels, 28.8.2013.
[122] Council Directive 2008/114/EC, *op.cit.,* Article 7.
[123] ERNCIP Project, http://ipsc.jrc.ec.europa.eu/index.php/ERNCIP/688/0/.
[124] DG HOME, *Terrorism and other Security-related Risks (CIPS)*, see: http://ec.europa.eu/dgs/home-affairs/financing/fundings/security-and-safeguarding-liberties/terrorism-and-other-risks/index_en.htm.
[125] DORATHEA Project, HOME/2010/CIPS/AG/030.

networks[126]; and an interactive risk assessment based on Earth Observation data and an integrated geographic information system[127].[128] In addition, several projects related to critical infrastructure protection are also being funded under the FP7 EU Research programme for a Secure Society[129] or by the research programme Environment. In this latest programme, new projects started since October 2013 – STREST (Harmonised approach to stress tests for critical infrastructures against natural hazards)[130] and INFRARISK (Novel Indicators for identifying critical INFRAstructure at RISK from natural hazards) – and should enable a higher infrastructure resilience capacity to rare and low probability extreme events, known as 'black swans'.

It is worth noting that due to increased inter-dependence of essential services, the disruption of one piece of critical infrastructure may trigger a domino effect causing disruption in the functioning of other key services. In effect, the Commission is encouraging a systems approach of risk assessment methodologies in which critical infrastructures are treated as an interconnected network.[131]

Analysis of national risk assessments

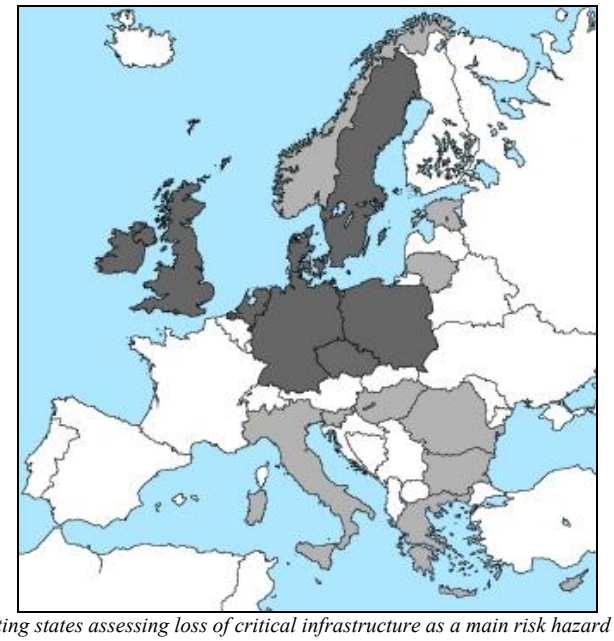
Loss of critical infrastructure was identified by seven Member States: Czech Republic, Germany, Ireland, the Netherlands, Poland, Sweden, and the United Kingdom. Ireland addresses 'loss of critical infrastructure' in general terms, while Poland, the Netherlands, Sweden and the United Kingdom focus on disruptions to energy supply linked to loss or damage to infrastructure "essential for the maintenance of vital societal functions"[132]. In the case of Germany's NRA, the threat of "outage of critical infrastructure" is to be understood as a heading which has to be specified during the scenario development. In fact, impacts on critical infrastructure and their services can be considered in the risk assessment of other natural and man-made hazards as part of the scenario structure, as is the case in risk assessment by Germany and Denmark.

As defined in Ireland's assessment, critical infrastructure generally includes airports, ports, power and communications networks, transport networks and water supplies. In addressing the risk of loss and/or damage of critical infrastructure, most NRAs however focus on power networks and water supplies (Ireland, the Netherlands, Sweden and the United Kingdom). Ireland and the United Kingdom stress that societal and economic reliance on supply in energy, gas, oil and water increases the impact of a threat to distribution infrastructure (dam failure scenario used by Sweden), thus justifying the high-level risk of this hazard.

In addition, Participating States underline the threat of potential damage to transport infrastructure and hubs in their risk assessment of transport accidents, looking at the economic impacts due to disruption in transport of goods and energy supplies (Denmark, Ireland, and the United Kingdom).[133]

[126] ASTROM Project, JLS/2008/CIPS/018.
[127] HOME/2010/CIPS/AG/037.
[128] SWD(2013) 318 final, Brussels, 28.8.2013, *op.cit.,* 7.
[129] European Commission, Directorate General for Enterprise and Industry (DG ENTR), Policy and Research in Security, available at: http://ec.europa.eu/enterprise/security.
[130] STREST Project, http://www.strest-eu.org.
[131] SWD(2013) 318 final, 28.8.2013, *op.cit.,* 7.
[132] DG HOME, *op.cit.*
[133] See section .3.3 Major transport accidents

Overall, while technological developments have improved the quality and resilience of power and transport networks, increased reliance on and use of both networks for supply in energy, mobility and trade increase the impact and potential likelihood of loss of critical infrastructure. The interdependency between power and communications is well documented, as is the dependency of transport on power, but the dependency of power on transport is less clear. Dependencies and interdependencies can certainly increase the impact of loss of critical infrastructure, but the link to the likelihood of such a loss is unclear. In fact, the quantitative assessment of the risk of loss of critical infrastructure in risk matrices provided in relevant NRAs confirms this analysis.



Map 15: Participating states assessing loss of critical infrastructure as a main risk hazard (DG ECHO, 2014)
(dark grey: participating states assessing hazard as a main risk; light grey: participating states not identifying this hazard in their submitted national risk assessments; white: countries for which no information is available)

4 MAN-MADE MALICIOUS DISASTER RISKS

4.1 Cyber-attacks

Cyber-attacks present both current and emerging risks as European societies are increasingly dependent on electronic networks and information systems. Information and Communication Technology (ICT) is central to our economic growth and is critical to the functioning of our European economic sectors. ICT underpins the systems on which vital sectors rely on. The uninterrupted availability of the internet and smooth information systems are central to many business models.[134]

Cyber-attacks are electronic attacks targeting ICT such as networks, computers and services, either directly or indirectly connected to the internet. Cyber-attacks to which individuals, organisations and networks are exposed can be broken down in two categories: syntactic attacks using malicious software (e.g. viruses, worms and Trojan horses) relevant to cyber espionage and sabotage, and semantic attacks, through the dissemination of incorrect information to affect credibility of the target resources, relevant in the case of cyber subversion. The Stuxnet virus is a case of cyber sabotage,

[134] European Commission and High Representative of the European Union for Foreign Affairs and Security Policy, *Joint Communication on Cybersecurity Strategy of the European Union: An Open, Safe and Secure Cyberspace*, JOIN(2013) 1 final, Brussels, 7.2.2013, 2.

which consisted in a malicious code used to attack the Siemens controllers used in nuclear facilities in Iran. While its impact is questionable – it may have delayed the Iranian nuclear programme – it confirmed that such a virus could conceivably lead to the functioning meltdown of a nuclear power plant, the closure of pipelines or even a modification to the chemical composition of tap water. A recent case of cyber espionage is the cyber tool GhostNet discovered in 2009 responsible for the infection of thousands of government and international organisation, news media and NGO computers across 130 different countries. This virus infected the computers' hard drives, recorded keystrokes and activated cameras and microphones. An example of cyber subversion is the infiltration of US technology security firm HBGary in 2011 by a group of activist hackers, Anonymous, publishing private emails, taking down phone systems, and hacking the company's website.[135]

A Commission Communication on the Cyber security Strategy of the European Union confirms that cyber-attacks "are increasing at an alarming pace and could disrupt the supply of essential services we can take for granted such as water, healthcare, electricity or mobile services".[136] As part of the Strategy, the Commission adopted a proposal for Directive on network and information security (NIS) with the aim of enhancing national capabilities and EU-level cooperation against cyber incidents. The proposal also requires operators of energy, transport, banking and health services as well as key internet platforms and public administrations to take appropriate risk management measures and to report significant incidents to their national competent authority. Other areas of the economy exposed to such threats include government services, disaster services, food and agriculture, transport, financial services and distribution. Overall, damages caused by cybercrimes are globally estimated around $1 trillion annually. The protection of cyber space has thus become a primary issue for most countries.

In an effort to tackle European vulnerability to cyber security incidents, the European Commission adopted in 2001 a Communication on Network and Information Security (NIS)[137]. A European Network and Information Security Agency (ENISA) was also created in 2004[138]. In 2006, it adopted a Strategy for a Secure Information Society[139] and has adopted, since 2009, an Action Plan and a Communication on Critical Information Infrastructure Protection (CIIP)[140]. A Joint Communication by the Commission and the High Representative of the EU for Foreign Affairs and Security Policy on a Cybersecurity strategy of the EU "outlines the EU's vision in this domain,

---

[135] World Economic Forum, *Insight Report: Global risks 2012, Seventh Edition*, 2012, 25, available at: http://reports.weforum.org/global-risks-2012/.

[136] JOIN(2013) 1 final, 7.2.2013, *op.cit.,* 3.

[137] European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Network and Information Security: Proposal for a European Policy Approach*, COM(2001) 298 final, Brussels, 6.6.2001.

[138] European Union Agency for Network and Information Security (ENISA), http://www.enisa.europa.eu/.

[139] European Commission, *Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on a strategy for a Secure Information Society – Dialogue, partnership and empowerment*, COM(2006) 251, Brussels, 31.5.2006.

[140] European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Critical Information Infrastructure Protection Protecting Europe from large scale cyber-attacks and disruptions: enhancing preparedness, security and resilience*, COM(2009) 149 final, Brussels, 30.3.2009; European Commission, *Communication on Critical Information Infrastructure Protection Achievements and next steps: towards global cyber-security*, COM(2011) 163 final, Brussels, 31.3.2011.

clarifies roles and responsibilities and sets out the actions required based on strong and effective protection and promotion of citizens' rights to make the EU's online environment the safest in the world".[141] At Member State level, the Bank of England Financial Policy Committee have recommended that HM Treasury and other relevant bodies work with the core UK financial system and its infrastructure on developing a programme to improve and test the resilience of the financial system to cyber-attacks.[142]

Analysis of national risk assessments

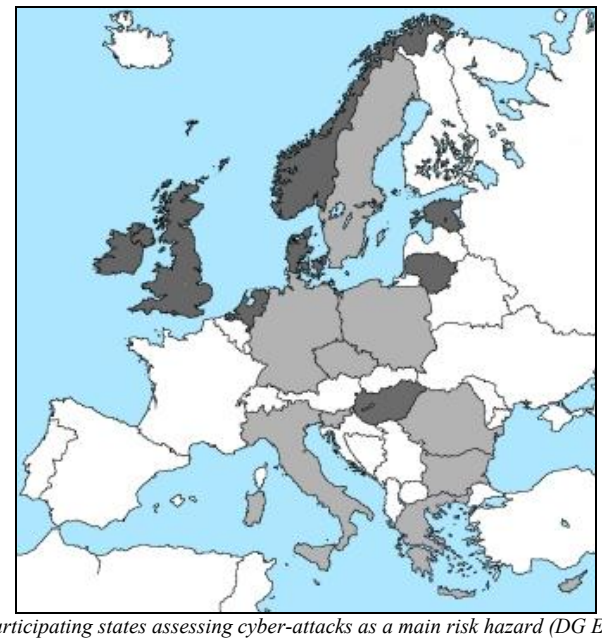
The risk of cyber-attacks is identified by: Denmark; Estonia; Hungary; Ireland; Lithuania; the Netherlands; Norway; Poland; and the United Kingdom.

Cyber-attacks remain an emerging risk insofar that no real agreement exists on the nature and gravity of such threat. Denmark, Estonia, Ireland, Lithuania, the Netherlands, Norway and the United Kingdom have indicated the growing importance of assessing the risk of cyber-attacks due to our increasing reliance on ICT and vulnerability to these attacks. In addition, the rapidly changing nature of such attacks as a result of developments in ICT renders the quantification of and response to this threat difficult.

The cyber-attack scenario is the highest scoring risk for the Netherlands, the highest scoring technological hazard for Ireland and one of few 'very-high risk emergencies' for Estonia. Lithuania and Estonia indicate a very high probability of occurrence, due to increasing reliance on ICT, the unpredictability of the source of aggression and the frequency of past cyber-attacks.

The cross-border dimension of this threat is relevant insofar that the target data of such attacks is not generally limited to the local, regional or national levels: Lithuania indicates that a cyber-attack on Lithuania may most likely also target data relevant to the EU and NATO. A cross-border dimension to this threat also lies in the source of the aggression: both Denmark and the United Kingdom define 'foreign powers' as major threats to their cyber-security. The global dimension of this threat is clear, as sources of aggression can be located anywhere around the globe and can, in cases, be directly linked to the threat of terrorism.

[141] JOIN(2013) 1 final, 7.2.2013, *op.cit.,* 3.
[142] Bank of England Financial Policy Committee, *Financial Stability Report Issue No. 33*, June 2013, 5, available at: http://www.bankofengland.co.uk/publications/Documents/fsr/2013/fsrfull1306.pdf.



Map 16: Participating states assessing cyber-attacks as a main risk hazard (DG ECHO, 2014)
(dark grey: participating states assessing hazard as a main risk; light grey: participating states not identifying this hazard in their submitted national risk assessments; white: countries for which no information is available)

4.2 Terrorist attacks

Historically, **terrorist attacks** in Europe have primarily been carried out by groups with local objectives, such as Euskadi Ta Askatasuna (ETA) in Spain and the Irish Republican Army (IRA) in the United Kingdom. However, since the 9/11 attacks in the US in 2001, several terrorist attacks have been carried out by al-Qaeda linked groups in Europe. In 2004, an attack which killed 191 people in Madrid was linked to an al-Qaeda-inspired terrorist cell. Similarly, in 2005 a terrorist attack targeting London's public transport system was linked to al-Qaeda. While a number of planned terrorist attacks have been prevented by the police and security services in the past decade, the recent attacks in Oslo and Utoya (Norway, 2011), in Toulouse (France, 2012) and Burgas (Bulgaria, 2012) demonstrate that the terrorist threat in Europe remains diverse and may be driven by a variety of motivations, including religion, nationalism and separatism, political extremism (right-wing, left-wing and anarchist terrorism).

Since the 9/11 events, the cooperation within the EU in the fight against terrorism has intensified. A first strategy and subsequent action plan were stepped up after the US attacks. The EU adopted a framework decision[143] urging Member States to align their legislation. The framework also defines terrorism offences and harmonises the penalties that EU countries must incorporate in their national legislation. In 2008, following the UK liquid bomb plot, the EU adopted the EU Action Plan [144] on Enhancing the Security of Explosives, which introduced a number of key actions aimed at preventing the use of commercial and home-made explosives from being used against any member of the public. Among many actions taken, the European Commission launched a Gap Analysis on detection of explosives to measure the existing protection capabilities against future attacks. This EU gap analysis process is continuously revised and provides, together with other tools such as Europol's Explosive Ordinance Disposal Network (EEEODN),

[143] Council Framework Decision of 13 June 2002 on combating terrorism (2002/475/JHA), *Official Journal of the European Communities*, L (164), 13.6.2002.
[144] Council of the EU, *EU Action Plan on Enhancing the Security of Explosives*, 8311/08, Brussels, 11.4.2008.

input for Member States on present and future protection measures against terrorist attacks.

According to the Annual reports[145] on the implementation of the EU's Counter-Terrorism Strategy[146], which was adopted in November 2005, and Europol's 'EU Terrorism Situation and Trend Report 2013 (TE-SAT 2013)'[147] the threat of terrorism in Europe remains strong and the number of attacks has increased. In terms of impact, a serious terrorist attack has the potential to have severe impacts resulting in high levels of mortality, economic losses, public disorder, etc.

While the overall terror threat poses a low to moderate risk in most European countries, the risk of terrorist attacks has become increasingly unpredictable due to the complexity and fragmented nature of the global terror threat, which emanates not only from structured groups and networks, but also from smaller EU-based groups and solo terrorists. The Europol report underlines the threat from religiously inspired terrorism and notes that the unstable situation in the Mediterranean and the Middle East region has a direct relation to the threat to the European countries' security. The convulse situation due to the civil war in Syria is also an issue of concern, as the country has become the most attractive theatre for radicalised EU citizens seeking to join jihadist groups. This phenomenon poses a significant risk as those "foreign fighters" may further radicalise, acquire specific skills and experience and return to the EU, possibly endangering the security of the EU and the Member States.

In line with the Objective 5 of the Internal Security Strategy[148], the Commission has supported efforts to promote coherent risk-based policy. In the field of aviation security for instance, as a consequence of the discovery in 2010 of parcel bombs in an air cargo originating from Yemen, the Council mandated the establishment of common criteria for assessing risks posed by cargo from non-EU countries, and the incorporation of aviation security risk assessment and relevant data into the parameters of the electronic customs risk assessment systems. Based on a methodological approach established with Member States, aviation security and terrorism experts, the European Commission, in cooperation with the EEAS and Member States, has established an on-going risk assessment process which has supported the decision on additional security measures with a view to close identified unacceptable security gaps. The same methodological approach, with the necessary adaptations, has guided subsequent risk assessments on the risks posed to aviation security by liquids and terrorist-related risks posed by passengers.

To complement additional security measures in the field of aviation against threats posed by cargo the European Commission is, in close cooperation with the Member States, aviation industry and at international levels, further developing standards and customs electronic systems to ensure all relevant elements for risk analysis and identification of high risk cargo are available before loading of cargo onto the aircraft in a foreign state.

---

[145] Council of the EU, *Annual report on the implementation of the EU Counter-Terrorism Strategy: Evaluation by the CTC and questions for discussion,* 16471/12, Brussels, 23.11.2012.
[146] Council of the EU, *The European Union Counter-Terrorism Strategy,* 14469/4/05, Brussels, 30.11.2005.
[147] Europol, *TE-SAT 2013: EU Terrorism Situation and Trend Report*, 2013, available at: https://www.europol.europa.eu/sites/default/files/publications/europol_te-sat2013_lr_0.pdf.
[148] European Commission, *Communication from the Commission to the European Parliament and the Council on the EU Internal Security Strategy in Action: Five steps towards a more secure Europe*, COM(2010) 673 final, Brussels, 22.11.2010.

In addition, due to the possibility that terrorist organisations could turn to unconventional weapons, such as chemical, biological, radiological or nuclear (CBRN) materials, in 2009 the Commission adopted its Communication on Strengthening Chemical, Biological, Radiological and Nuclear Security in the European Union – an EU CBRN action plan.[149] The Communication was based on the finding of a CBRN Task Force established by the Commission in February 2008. The Council adopted the conclusions of the Communication in November 2009[150]. The Action Plan focuses on prevention, detection, preparedness and response. It outlines national measures that address existing gaps and promote exchanges of information and best practices. However, in general the risk of a malign CBRN incident within the EU is deemed to be low. An overview of its implementation by the Member States and EU bodies is provided in the 2012 Progress Report on the Implementation of the EU CBRN Action Plan[151]. The European Commission, in addition to the research fora activities, also launched a programme of detection trials aimed to support the practitioners with the use of CBRN-E detection equipment in different public security domains (sport and VIP events, CIP, transport etc.). Several projects related to the protection of citizens against chemical, biological, radiological, nuclear and explosives (CBRNE) threats are also being funded under the EU FP7 work programme for Secure Society.[152]

Analysis of national risk assessments

The risk of terrorist attacks has been identified by: Denmark, Ireland, Sweden, Hungary, Norway, the Netherlands, Poland; and the United Kingdom.

The United Kingdom, the Netherlands, and Sweden have identified terrorism as a serious or substantial threat to the country. However, the risk assessment of terrorist attacks can be classified and therefore unavailable, as is the case for Slovenia.

Northern European countries, in particular, Denmark, Sweden and the Netherlands have identified terrorist attacks as a potential threat especially since the 9/11 attacks.

The Centre for Terror Analysis (CTA) in Denmark considers that the terror threat against Denmark remains significant mentioning in particular the Cartoon Case, which in 2005 resulted in terrorist threats against Denmark by militant Islamist terrorist networks. In its latest report from July 2013, the Netherlands maintains that the threat level for the Netherlands is 'substantial'.[153]In 2010, two bombs attacks in central Stockholm (Sweden) were linked to Islamic terrorism and are the first official suicide attacks in Scandinavia.

[149] European Commission, *Communication from the Commission to the European Parliament and the Council on Strengthening Chemical, Biological, Radiological and Nuclear Security in the European Union – an EU CBRN Action Plan*, COM(2009) 273 final, Brussels, 24.6.2009.
[150]Council of the EU, *Adoption of the Council Conclusions on the Communication Strengthening chemical, biological, radiological and nuclear (CBRN) security in the European Union – an EU CBRN Action Plan*, 15505/1/09 REV1, Brussels, 12.11.2009.
[151] European Commission, *Progress Report on the Implementation of the EU CBRN Action Plan*, May 2012.
[152] DG ENTR, *op.cit.*
[153] The Netherlands has a National Coordinator for Security and Counter-terrorism to deal with and assess the threat of terrorist attacks, which is also in charge of coordinating the National Risk Assessment: see https://english.nctv.nl/.

Some countries (Hungary, Norway and the United Kingdom) mention the difficulty in assessing the risk and consequences of terrorism and note that a more subjective methodology is required to assess this particular risk given that it is an intentional incident.

National risk assessments (the Netherlands, Hungary and the United Kingdom) note that terrorist attacks have the potential to cause national and transnational level disasters as they can also be linked to or associated with other risks (epidemics, pandemics, CBRN, industrial accidents, technical failure, severe weather and cyber-attacks). For example, bioterrorism or attacks against hazardous goods or stationary facilities with hazardous substances could cause large scale epidemics or pandemics.

Map 17: Participating states assessing terrorist attacks as a main risk hazard (DG ECHO, 2014)
(dark grey: participating states assessing hazard as a main risk; light grey: participating states not identifying this hazard in their submitted national risk assessments; white: countries for which no information is available)

5 MULTI-RISK DISASTERS

Many of the risks identified by Member States in their NRAs also mention the 'consequential' or 'cascade effects' of risks. A multi-risk approach analyses not only the risk but also takes into account possible cascade effects, i.e. the situation for which an adverse event triggers one or more sequential events. An in-depth multi-risk assessment requires an innovative approach which allows for a comparison of different risks while accounting for all the possible cascade events. It is not an alternative to a single risk analysis, since a single risk analysis is a necessary pre-requisite for a multi-risk analysis[154].

The FP7-funded MATRIX project[155] aims to develop new methods and tools to tackle multiple natural hazards in a common framework. Risk comparability, cascading hazards and time-dependent vulnerability in the frame of conjoint or successive hazards are explored in this context.

[154] Marzocchi W., et.al., Principles of multi-risk assessment, Interaction amongst natural and man-induced risks, *European Commission Project Report*, 2009, available at: http://ec.europa.eu/research/environment/pdf/multi-risk_assessment.pdf.
[155] MATRIX project, http://matrix.gpi.kit.edu.

It is predicated that the so-called 'cascade effects' of risk are likely to increase due to climate change, sea-level rise, more extreme weather conditions and the growth of population density in hazard risk zones.

5.1 Natural risks

In NRAs and progress reports submitted by Denmark, Norway, Romania, Hungary and the United Kingdom, severe weather phenomena such as storms, snowfall and heavy precipitation are clearly associated to an increased risk of floods and, in the case of Italy, with landslides. According to assessments provided by Hungary, Ireland and Lithuania, increased risks of forest fires are linked to severe weather events such as heat waves and lack of precipitation (i.e. droughts). Risks of earthquakes can be associated to a greater risk of landslides in mountainous areas as highlighted by Hungary and Italy), as well as tsunamis in the case of Greece. The generation of tsunamis by earthquakes, underwater landslides, underwater volcanic eruptions and impacts of meteorites is a real risk and can take different magnitudes.

5.2 Natech risks

Technological accidents involving the release of hazardous substances, fires, and explosions triggered by natural hazards (Natechs) are increasingly recognized as an emerging risk.[156] Natech is expected to increase in the future due to a greater number of natural and technological hazards (climate change, industrialization) and a higher vulnerability of society (urbanization, interconnectedness). While there is growing awareness of Natech risks, effective risk reduction is still hampered by a lack of Natech risk assessment methodologies and guidelines for Natech risk management. Across the NRAs submitted such as Denmark, Lithuania, Sweden and Norway, Natech risks include the cascade effects of severe weather phenomena such as storms and heavy precipitation on an increased risk of pollution, loss of critical infrastructure and transport accidents resulting from difficult manoeuvring conditions. As underlined by Norway, Italy, Greece and the United Kingdom, risks of landslides, earthquakes and volcanos can increase risks of transport accidents and loss of critical infrastructure.

5.3 Technological and man-made risks

Direct correlation is drawn by Denmark, Lithuania, the United Kingdom and Norway between risks of nuclear, chemical and transport accidents and the loss of critical infrastructure with an increased risk of contamination and environmental pollution. In fact, the United Kingdom and Ireland also point to the impacts of risks of loss of critical infrastructure on risks of flood and environmental pollution, as well as further cascade effects on other forms of critical infrastructures across a range of sectors. The loss of critical infrastructure, nuclear and industrial accidents may also be linked to increased risks of terrorist and cyber-attacks, as indicated by Norway and the United Kingdom. According to Estonia and Sweden, environmental pollution – through water or air pollution – may result in greater risks of disease outbreaks. Finally, in its assessment of pandemics risks, Denmark underlines the link with loss of critical infrastructure due to manpower shortages.

[156] Krausmann E., Baranzini D., "Natech risk reduction in the European Union", *Journal of Risk Research*, 15:8, 2012; see also RAPID-N, *op.cit.*

6 EMERGING DISASTER RISKS

6.1 Impact of climate change and ecosystem degradation

Contributions by Member States have highlighted the role of climate change as a threat multiplier and the importance of climate change adaptation. Either directly or indirectly, fast and slow-onset in weather patterns increase the likelihood (floods, forest fires, severe weather, etc.), as well as the impacts (transport accidents, industrial accidents, etc.) of hazards. The Global Risks Landscape (Figure 1.1 of the World Economic Forum's Global Risk Report[157]) features loss of biodiversity and ecosystem collapse amongst the 10 most likely risks with the highest impact.

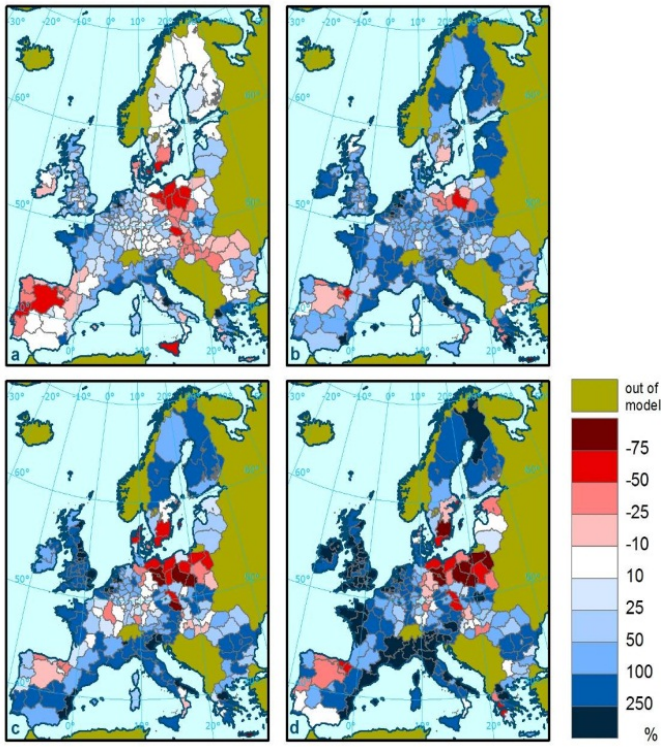
6.1.1 Natural hazards

The Commission Communication on an EU Strategy on adaptation to climate change points to the increase of extreme events resulting from climate change and to the need for relevant adaptation; it states that "the consequences of climate change are increasingly being felt in Europe and worldwide. The average global temperature, currently around 0.8°C above pre-industrial levels, continues to rise. Some natural processes are being altered, precipitation patterns are changing, glaciers are melting, and sea levels are rising".[158]

Extreme events have increased in Europe, with more heat waves, droughts and forest fires in southern and central Europe, while the number of floods and heavy precipitation has increased in Northern and North-eastern Europe. The likely increase in magnitude of such events would lead to significant economic and human consequences.[159] Projected impacts in Europe for some of these extremes are available.

Firstly, a simulation of the future developments in the expected annual damages resulting from floods is illustrated below. This study presents an appraisal of the socio-economic impacts of river floods in the European Union in view of climate and socio-economic changes. Results indicate that current expected annual population affected of ca. 200,000 is projected to increase up to 360,000 due to the effects of socio-economic development and climate change. An analysis of the potential costs of adaptation associated with the increase in protection suggests that adaptation could be highly cost-effective. There is, however, a wide range around these central numbers reflecting the variability in projected climate. Analysis at the country level shows high damages, and by association high costs of adaptation, in the United Kingdom, France, Italy, Romania, Hungary and Czech Republic. At the country level, there is an even wider range around these central values, thus, pointing to a need to consider climate uncertainty in formulating practical adaptation strategies.

[157] Global Risk Report, 2014, *op.cit.,* 16.
[158] COM(2013) 216 final, 16.4.2013, *op.cit.,* 2.
[159] Council Conclusions on the Communication An EU Strategy on adaptation to climate change, 11151/13, *Environment Council meeting*, Luxembourg, 18.6.2013.



Map 19: Change in Expected Annual Damages (averaged over administrative level NUTS2) from floods compared to the baseline period (1961-1990) for the 2000s (a), 2020s (b), 2050s (c) and 2080s (d), all for the A1B scenario[160]. Ensemble average results based on LISFLOOD simulations driven by 12 regional climate models for the IPCC SRES A1B scenario (Rojas et al., 2013[161]).

Secondly, there is growing concern in Europe about the possible rise in the severity and frequency and heat waves of extreme drought events as a manifestation of climate change. Russo et al.[162] have analysed the changes in probabilities for the occurrence of extreme dry and wet years and seasons across Europe up to the end of the 21st century. They show that the probability of having an extreme precipitation season is increasing over all of Europe, with wet and dry regions becoming, respectively, wetter and drier. These authors further calculate that a heat wave like the one in summer 2003 could become normal by 2060 onwards (Russo et al., 2014, in preparation).

Forzierri et al. have addressed the issue of future developments in streamflow drought characteristics across Europe[163]. This analysis shows that streamflow droughts will become more severe and persistent in many parts of Europe due to climate change, except for northern and north-eastern parts of Europe. In particular, southern regions will face strong reductions in low flows. Future water use will aggravate the situation by 10–30% in Southern Europe, whereas in some sub-regions in Western, Central and

[160] Scenario A1B is one of three groups of the A1 scenario family developed by the Intergovernmental Panel on Climate Change (IPCC) to describe a different world evolving through the 21st century, and each potentially leading to quite different GHG emissions trajectories and on which SRES scenarios are based. A1 corresponds to a future world of very rapid economic growth, global population that peaks mid-century and declines thereafter, and rapid introduction of new and more efficient technologies; A1B corresponds to the group in which technological change in the energy system is balanced across all sources: see http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=154.

[161] Rojas R., Feyen L., Watkiss P., "Climate change and river floods in the European Union: Socio-economic consequences and the costs and benefits of adaptation", *Global Environmental Change*, 23:6, 2013, 1737-1751.

[162] Russo S., et al., "Projection of Occurrence of extreme dry-wet years and seasons in Europe with stationary and non-stationary Standardized Precipitation Index", *Journal Geophysical Research: Atmospheres*, 118, 2013, 1-12.

[163] Forzieri G., et al., "Ensemble projections of future streamflow droughts in Europe", *Hydrology and Earth System Sciences*, 18:1, 2014, 85-108.

Eastern Europe a climate-driven signal of reduced droughts may be reversed due to intensive water use.

It is expected that climate change will cause more extreme weather in the future, exposing ecosystems and communities to increased intensity and frequency of severe weather particularly in the coastal zones (four times as many recorded disasters worldwide in 2009 as in 1970).[164] For instance, sea level rise (in combination with storm surges) could increase the risk of flooding, coastal erosion and salt water intrusion to groundwater resources and to rivers/deltas and estuaries in these areas. Hinkel et al. (2009[165], 2010[166]) suggest that the United Kingdom, the southern part of the Baltic coast and the north-western Mediterranean coast are highly vulnerable to sea level rise flooding, especially in a high-greenhouse gas emission climate scenario. Under a no-adaptation scenario, it is estimated that between 200,000 (low-emission scenario) and 780,000 people (high-emission scenario) people could be affected by coastal flooding by 2100. The Climate Cost project[167] assessed the potential economic impact of climate change in Europe's coastal zones using the DIVA model[168]. Projections under a medium to high emission scenario estimate a 0.37 m sea level rise for Europe in the 2080s. Without further upgrade on coastal protection, this would translate into average estimated damage costs of €25 billion annually. The analysis also suggests that European wetlands will be heavily impacted, leading to economic loss that have not yet been fully valued.

Fourthly, forest fires are likely to increase, particularly large fires as well as the fire-prone areas that will expand in Europe. According to the PESETA II Project which focuses on the economic impacts of climate change, "climate change seems among the most important drivers of wildfire potential over time in Europe".[169] The European Commission is also funding under FP7 the research project FUME addressing forest fires under climate and land-use change[170]; it has already shown that with continued global warming, fire danger conditions will increase in average and extremes and that the fire season will be longer throughout Europe.

The Commission Communication on "Our life insurance, our natural capital: an EU biodiversity strategy to 2020"[171] stresses that biodiversity — the extraordinary variety of ecosystems, species and genes that surround us — is our life insurance, giving us

[164] Beck M.W., Shepard C.C., "Coastal Habitats and Risk Reduction", *World Risk Report*, 2012, 32, available at: http://www.ehs.unu.edu/file/get/10487.pdf. See also EEA, 2012, *op.cit.* See also IPCC, "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)", *Special Report,* 2012, available at: http://ipcc-wg2.gov/SREX/.
[165] Hinkel J., et al., "The vulnerability of European coastal areas to sea level rise and storm surge", *Contribution to the EEA SOER 2010 report*, Potsdam Institute for Climate Impact Research (PIK), 2009.
[166] Hinkel J., et al., "Assessing risk of and adaptation to sea-level rise in the European Union: an application of DIVA". *Mitigation and Adaptation Strategies for Global Change*, 15, 2010, 703–719.
[167] ClimateCost Project, http://www.climatecost.cc/. The project took into account damage and adaptation costs. Damage costs include: total annual damage costs (2005 price), including the number of people forced to move due to erosion and submergence (assuming the cost for people that move is 3x the value of their per-capita GDP; land-loss costs (land below the 1-in1 year flood level) taking into account dikes and direct erosion ignoring nourishment, salinisation costs and the expected costs of sea and river floods. Adaptation costs include the sum of sea dikes, river dikes and beach nourishment.
[168] DIVA Model, http://www.diva-model.net/.
[169] PESETA II Project, http://peseta.jrc.ec.europa.eu/methodology.html.
[170] FUME Project, http://www.meteo.unican.es/en/projects/fume.
[171] European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Our life insurance, our natural capital: an EU biodiversity strategy to 2020,* COM(2011) 244 final , Brussels, 3.5.2011.

food, fresh water and clean air, shelter and medicine, mitigating natural disasters, pests and diseases and contributes to regulating the climate. Biodiversity is also our natural capital, delivering ecosystem services that underpin our economy. Biodiversity loss, though not striking suddenly, is certainly one of the major threats to living conditions on earth, fragilising the capacity for resilience of natural and man-made ecosystems, and related ecosystem services. Its deterioration and loss jeopardises the provision of these services: loss of species and habitats and the wealth and employment to be derived from nature, and endangerment of wellbeing. This makes biodiversity loss the most critical global environmental threat alongside climate change — and the two are inextricably linked.

Current rates of species extinction are unparalleled. Driven mainly by human activities, species are currently being lost 100 to 1,000 times faster than the natural rate: according to the FAO, 60% of the world's ecosystems are degraded or used unsustainably; 75% of fish stocks are over-exploited or significantly depleted and 75% of the genetic diversity of agricultural crops has been lost worldwide since 1990. An estimated 13 million hectares of tropical forests are cleared each year and 20% of the world's tropical coral reefs have already disappeared, while 95% will be at risk of destruction or extreme damage by 2050 if climate change continues unabated.

While biodiversity makes a key contribution to climate change mitigation and adaptation, achieving the '2 degrees' target coupled with adequate adaptation measures to reduce the impacts of unavoidable effects of climate change are also essential to avert biodiversity loss.

Finally, changing climate conditions may also cause an increase in the spread of serious infectious vector-borne transmissible diseases affecting humans and/or animals. The rise in temperatures and changing climate conditions may indeed lead to the development of new fertile environments for certain forms of virus. In the case of flu pandemics, warmer winters may disrupt the seasonal distribution of flu pandemics (spreading to autumn and spring) affecting populations unexpectedly thus increasing their vulnerability.[172]

6.1.2 Implications for infrastructure

The impact of climate change, causing more regular and severe weather conditions, will also have a cascade effect on the increased risk of industrial, transport or infrastructure incidents. A Staff Working Document annexed to the Commission Communication on the EU strategy on climate change adaptation indicates that the rise in temperatures and sea levels as well as the increased frequency and intensity of extreme weather events, such as storms, heat waves and flooding, already have a significant impact on the functioning of transport and energy infrastructure.[173] These impacts will vary according to location, geophysical risk exposure, adaptive capacity and resilience and level of regional economic development.[174] In addition, the use of infrastructure becomes more

[172] European Commission, *Commission White Paper on Adapting to climate change: Towards a European framework for action*, COM(2009) 147/4, Brussels, 2009, 4; European Commission, *Commission Staff Working Document on Adapting to climate change impacts on human, animal and plant health accompanying the Communication An EU Strategy on adaptation to climate change COM(2013) 216 final*, SWD(2013) 136 final, Brussels, 16.4.2013, 4-6.
[173] European Commission, *Commission Staff Working Document on Adapting infrastructure to climate change accompanying the Commission Communication An EU Strategy on adaptation to climate change COM(2013) 216 final*, SWD(2013) 137 final, Brussels, 16.4.2013, 11.
[174] SWD(2013) 137 final, 16.4.2013, *op.cit.,* 7.

hazardous under severe weather conditions with a higher number of serious road traffic crashes as a possible outcome.

Impacts on transport infrastructures under extreme weather events were addressed by the EU-funded projects WEATHER[175] assessing the impacts of weather extremes on transport systems and hazards for European regions and EWENT[176] assessing the impacts and consequences of extreme weather events on EU transport systems, and MOWE – IT[177] corroborating existing information from previous projects and providing short and long - term policy recommendations on mitigation. According to the EEA, Natech accidents, industrial accidents resulting from natural events such as floods, storms, earthquakes and forest fires, are also occurring more frequently due to the increased frequency of extreme natural hazards.[178]

In the case of energy, climate change will mean interconnected risks for electricity security and for investment costs in the energy sector, including: Increased risk of flooding of energy infrastructure (including power stations and sub-stations); Higher incidence of extreme weather events impacting on infrastructure resilience and creating disruptions; Variation of renewable energy resource availability and output (solar radiation, water, etc.); Potential reduction of efficiency in power station outputs (e.g. lower cooling efficiency of warmer water or decreased availability of cooling water) and power transmission (e.g. capacity of overhead lines affected by temperature changes); and changes in energy demand patterns, possibly increasing the risk of the impact of demand peaks exceeding grid capacity.

6.1.3 Migration in the context of climate change

Finally, worsening environmental conditions, combined with increased extreme natural phenomena, may trigger unanticipated social and economic processes leading to a geographical redistribution of capital and labour.

As highlighted in the Commission's April 2013 Staff Working Document on Climate Change, Environmental Degradation and Migration[179], evidence currently available would suggest that most movements will happen in an intra-state context or within developing regions, and mainly from rural to urban environments. Those most likely to migrate will be persons in the poorest segments of societies affected by climate change who already face multiple stressors to livelihoods and are therefore highly vulnerable to the effects of environmental degradation. Given that international migration requires substantial resources, especially if it is inter-regional, new large-scale international population movements to developed regions such as Europe are unlikely. Nevertheless, the possibility of indirect migratory effects on the EU should continue to be explored, as highlighted in a number of Member States' contributions to this overview.

The reality of migration in a climate change context will present challenges (and opportunities) to both countries/areas of origin and destination, in particular in the developing world[180]. Although no legal framework addressing the specific case of

[175] WEATHER project, www.weather-project.eu.
[176] EWENT project, http://ewent.vtt.fi/.
[177] MOWE – IT project, http://www.mowe-it.eu.
[178] EEA, 2010, *op.cit.,* 111.
[179] SWD(2013) 138 final, 2013, *op.cit,*
[180] See also: European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Maximising the Development Impact of Migration*, COM(2013) 292 final, Brussels, 21.5.2013.

environmentally-induced migration currently exists, a number of international and national instruments in areas such as international human rights law, international refugee law, and environmental law may provide frameworks for addressing related challenges (e.g. the UN Guiding Principles on Internal Displacement for the protection of victims of natural disasters). At EU level, the Temporary Protection Directive[181] does not specifically target climate-induced migration but can be applied by the Council in case the EU is facing a mass influx of displaced persons, even if it does not specifically target migration related to climate change. Two Member States (Sweden and Finland) have included provisions concerning people affected by natural disasters in their legislation on refugee-type protection and/or temporary protection; however, these provisions have never been applied.[182]

In the EU strategy on adaptation to climate change, the European Commission stresses that further work on slow-onset environmental degradation should focus on identifying disaster risk management mechanisms that can avoid or reduce the need for migration. This can be achieved through contributions to disaster risk reduction with actions in water management, biodiversity, forests, desertification, coastal erosion, energy, health, social policy and research.[183] At international level, a 2012 United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (CoP) Decision, on approaches to address loss and damage associated with climate change impacts in developing countries, acknowledges work on how impacts of climate change are affecting patterns of migration, displacement and human mobility.[184]

6.2 Space Environmental Hazards

In its Resolution of 26 September 2008, 'Taking forward the European space policy', the Council recalls that space assets have become indispensable for our economy and that their security must be ensured.[185] Space infrastructure is a critical infrastructure on which services that are essential to the smooth running of our societies and economies as well as our citizens's security depend. This infrastructure is exposed to specific threats related to the space environment and by studying these threats it appears that they can also directly impact earth populations and ground based infrastructure.

6.2.1 Space debris

Space debris has become the most serious threat to the security, safety and sustainability of space activities. 'Space debris' means any space object including spacecraft or fragments and elements thereof in Earth orbit or re-entering the atmosphere, that are non-functional or no longer serve any specific purpose including parts of rockets or artificial satellites, or inactive artificial satellites. Space debris can also threaten earth population after the re-entry into the earth atmosphere. Contrary to other space environmental hazards, the risk induced by space debris increases exponentially as break up or collision of space objects create chain reactions across the orbits.

---

[181] Council Directive 2001/55/EC on minimum standards for giving temporary protection in the event of a mass influx of displaced persons and on measures promoting a balance of efforts between Member States receiving such persons and bearing the consequences thereof, *Official Journal of the European Communities*, L (212), 7.8.2001.
[182] SWD(2013) 138 final, 2013, *op.cit.,* 18.
[183] *Ibid.,* 24.
[184] United Nations Framework Convention on Climate Change (UNFCCC), *Report of the Conference of the Parties on its eighteenth session, held in Doha from 26 November to 8 December 2012*, 28.02.2013, available at: http://unfccc.int/resource/docs/2012/cop18/eng/08a01.pdf.
[185] *Council Resolution Taking forward the European Space Policy,* CS 13569/08, Brussels, 29.09.2008.

With increasing population of satellites in orbit, the number of uncontrolled re-entry events can be assumed to increase over the coming years.[186] According to latest estimates, there are 16,000 (catalogued) objects orbiting Earth larger than 10cm, and between 300,000 and 600,000 or 740,000 objects larger than 1cm (not catalogued). According to the European Space Agency, the population of objects larger than 1 cm will continue to grow, and will reach a total of approximately 1 million debris in 2020. Furthermore, it is estimated that there are more than 300 million objects larger than 1mm.[187]

The EU is promoting a Code of Conduct on outer space activities which proposes a set of transparency and confidence-building measures designed to contribute to enhancing the safety, security and sustainability of outer space activities including measures on Space Operations and Space Debris Mitigation. Research activities are also on-going in the framework of EU Horizon 2020 to mitigate the risks induced by Space debris and prevent proliferation such as active debris removal or passivation techniques.

To detect and track space debris, the EU will establish a support framework for space surveillance and tracking (hereinafter referred to as 'SST'). The aim is to support the setting up and operation of services consisting of monitoring and surveying space objects in order to prevent damage to spacecraft resulting from collisions and proliferation of space debris, and to predict trajectories and re-entry paths. As such, the support framework will assess the risks of a collision between spacecraft and space debris and generate collision avoidance alerts to the spacecraft operators and provide information to governmental and civil protection services in case of uncontrolled re-entries of entire spacecraft or space debris thereof into the Earth's atmosphere.

6.2.2 Space Weather phenomena

Space weather can be defined as "*conditions on the Sun and in the solar wind, magnetosphere, ionosphere and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health*"[188]. Space weather includes a number of phenomena, such as solar flares, coronal mass ejections; and solar energetic particle events, causing geomagnetic storms, radiation storms and solar radio noise. These can occur at any time during the 11-year solar cycle but during solar maximum, activity on the sun and the possibility of space weather phenomena is higher. The present solar cycle is not behaving as predicted: a 'solar maximum' was expected between 2012 and 2015, but does not appear to be materialising. However severe solar events can occur at any time during the cycle, and so the importance of the cycle for risk management is very limited

Space weather can impact on daily life in various ways. While evidence shows that solar storms are not a new hazard, its severity has increased with the emergence of vulnerable technologies. The growing use of advanced technologies by governments and businesses increases exposure and vulnerability to space weather hazards. In the

[186] Impact Assessment accompanying the document Proposal for a Regulation concerning the setting up and operations of European space surveillance and tracking (SST) services
[187] Ecorys, "Study on the EU Space Programme 2014-2020", *Draft Final Report*, 18.4.2010, contract n. SI2.541751; Booz & Company , Study "evaluation of options for a space programme in 2014-2020", *Final report*, 16.5.2011, contract n. ENTR/2009/050 lot 1.
[188] Definition produced by NASA's Solar and Heliospheric Observatory (SOHO), http://sohowww.nascom.nasa.gov/spaceweather/.

case of severe space weather, ensuing disturbances may affect the power[189] and transport sectors: increased radiation will affect air traffic particularly on transpolar but also potentially over oceans and deserts, since commercial aeroplanes are required to be in contact with ground services. It will also affect all radio systems, especially synthetic aperture radar systems. Railway systems may suffer disruptions to signalling systems or to on-train equipment.

Furthermore relatively mild solar events may also render Global Navigation Satellite Systems (GNSS) unavailable, sometimes for quite long periods; and more and more other infrastructures, including financial trading systems and navigation systems, are coming to rely on GNSS signals for timing or location.

The consequences of an extreme solar event could be very severe and awareness of the risk to infrastructures is growing among operators and regulators. Vulnerability to this hazard is identified as one of 50 key risks in the Global Risk Report 2012.[190] Space weather is also addressed across four of the submitted NRAs.

The systemic risk presented by the most severe cases of space weather would require adequate protection of government and business systems to adapt and mitigate its impact. In addition, the assessment of space-weather impact on society needs to consider possible interdependencies between critical infrastructure systems which are not routinely assessed. This is due to a lack of data that renders any assessment of the direct and indirect societal impacts of space weather difficult.

6.2.3 Near Earth Objects

A Near Earth Object (NEO) is any asteroid or comet that comes close to Earth, i.e. when the orbit of the object allows it to approach the Earth's orbit closer than about 45 million kilometres. A subcategory of NEOs is Potentially Hazardous Asteroids (PHA). These asteroids have the potential to be a hazard to Earth. PHAs are defined by how close their orbit comes to that of the Earth, and their intrinsic brightness, which is an indicator of their size. The impact of an object of this size could have very serious regional impacts. In the worst case, they could entirely destroy a large city or an urban area).[191]

Scientists from around the world have long been interested in studying the phenomenon of NEOs. Research in this field has also been funded in the framework of EU FP7 and in the context of the European Space Agency's Space Situational Awareness preparatory programme.

6.3 Anti-microbial resistance

Antimicrobial resistance (AMR) is identified in the World Economic Forum's Global Risks 2014 as one of seven global societal risks and one of ten global risks scoring above the average risk score of the risk assessment Global Risks Landscape 2014.[192]

[189] Krausmann E., et al., *Space Weather and Power Grids: Findings and Outlook*, Publications Office of the European Union, 2013.
[190] World Economic Forum, 2012, *op.cit.*
[191] Neoshield Project, http://www.neoshield.net/en/index.htm.
[192] World Economic Forum, 2014, *op.cit.,* 13-15.

Like pandemics, antimicrobial resistance is by nature a cross-border risk which affects populations in Europe and beyond. Antimicrobial resistance can be defined as "*the ability of microorganisms to withstand treatment with drugs to which they were once susceptible*"[193].

Antimicrobial agents, in the case of antibiotics for example, have led to a dramatic reduction in the number of deaths from infectious diseases since their introduction 70 years ago. However, the overuse and misuse of these agents have caused many micro-organisms to become resistant to them. This development is a growing concern as these agents have become essential tools for modern medicine, being used in many surgical operations.

According to the European Centre for Disease Prevention and Control (ECDC)[194], some 25,000 deaths annually are the result of antimicrobial resistance (AMR) and incur related costs of over €1.5 billion in healthcare expenses and productivity losses. Data from the European Antimicrobial Resistance Surveillance Network (EARS-Net[195]) shows developments in the AMR situation in Europe through large variations with regard to pathogen types, antimicrobial agents and geographical regions: in its annual report, the EARS-Net states that *"the already high percentages and increasing trends of antimicrobial resistance in gram-negative bacteria in Europe […] illustrate the continuous loss of effective antimicrobial therapy against these microorganisms and emphasise the need for comprehensive strategies targeting all health sectors".*[196]

A Commission Action Plan against the rising threat from antimicrobial resistance contains 12 actions for implementation.[197] The Action Plan identifies 7 priority areas in which measures are most necessary: ensuring appropriate use of antimicrobials in both humans and veterinary medicine; preventing microbial infection and spreading; developing new effective antimicrobials or alternative treatments; joining forces with international actors to contain the risk of spreading AMR; improving medical surveillance and monitoring; promoting research and innovation; improving communication, education and training.

The EU Framework Programmes for Research have prioritised research to combat antimicrobial resistance since 1999. Now nearly €800 million has been awarded to antimicrobial resistance projects, most in the area of human health, but also in the areas of animal health, food safety, environment and nanotechnologies. The projects address a variety of issues, ranging from strategies to reduce the use of antibiotics, to the development of new antibiotics and alternative approaches (phage therapy). In addition to this, EU funding has been invested alongside contributions from the pharmaceutical industry within the Innovative Medicines Initiative (IMI)[198] public private partnership

[193] Transatlantic Taskforce on Antimicrobial Resistance, "Recommendations for future collaboration between the US and EU", *Tatfar Report*, 2011, available at: http://ecdc.europa.eu/en/activities/diseaseprogrammes/tatfar/documents/210911_tatfar_report.pdf.
[194] ECDC, http://www.ecdc.europa.eu/en/Pages/home.aspx.
[195] EARS-Net is based on a network of representatives from Member States collecting routine clinical antimicrobial susceptibility data from national AMR surveillance initiatives; see: http://www.ecdc.europa.eu/en/healthtopics/antimicrobial_resistance/database/Pages/database.aspx.
[196] European Centre for Disease Prevention and Control, "Antimicrobial resistance surveillance in Europe", *Surveillance Report*, 2012, 1, available at: http://ecdc.europa.eu/en/publications/Publications/antimicrobial-resistance-surveillance-europe-2012.pdf.
[197] European Commission, *Communication from the Commission to the European Parliament and the Council on an Action Plan against the rising threats from Antimicrobial Resistance*, COM(2011) 748 final, Brussels, 15.11.2011.
[198] Innovative Medicines Initiative (IMI), http://www.imi.europa.eu/.

between the Commission and the European Federation of Pharmaceutical Industries and Associations. Notably through the "New drugs for bad bugs" programme which has made available a budget of some €600 million to boost the development of new antimicrobials. Furthermore, the Commission supports the Joint Programming Initiative on AMR (JPIAMR)[199] in which Member States are closely collaborating to tackle antimicrobial resistance, coordinate their activities and pool their national research in order to increase the effectiveness and impact of European public efforts.

7 CONCLUSIONS

Disaster risk policies at a European level deal with a range of issues including natural and man-made disasters, health threats, industrial and nuclear risks, malicious threats, and others. Some regions have developed valuable expertise for particular types of risks. Risk assessments are a first step in seeking to mitigate such risks and establish appropriate mechanisms to prevent as much as possible their occurrence and impacts. Sharing these experiences will help further reducing the impacts of hazards and allow better cooperation in facing challenges ahead.

The objective of this document has been to provide an overview of the main natural and man-made disaster risks addressed and assessed by 17 Member States and Norway, and submitted to the European Commission. This has been done by compiling and analysing the content of each contribution and the assessment methodology and criteria used by Member States. A list of main risks, based on the frequency of denomination of risks across the NRAs, has been drawn. The 12 most frequently identified disaster risks are addressed in three different categories of this overview: natural hazards (floods, severe weather, wildfire/forest fire, earthquakes, pandemics, livestock epidemics/epizootics), man-made non malicious hazards (industrial, nuclear/radiological, major transport accidents, and loss of critical infrastructure), and man-made malicious threats (cyber and terrorist attacks).

Each risk has been individually analysed qualitatively using information provided by Member States and complemented with information retrieved from various other reports (Global Risk Report, etc.). A background for each risk and relevant work carried out at European level accompanies each analysis, presenting existing cooperation and pointing to potential areas for future cooperation.

All but one NRAs submitted so far have assessed the risk of floods. This observation confirms a history of policy and operational cooperation at European level. In fact, Poland, the United Kingdom, the Netherlands, Ireland, Italy, the Czech Republic, Slovenia, Estonia and Lithuania underline floods as a particularly high level risk hazard. Risks of severe weather, pandemics, and industrial accidents are recognised by over three quarters of NRAs and are often assessed as one of the highest-level risk hazards to which countries are exposed.

Certain hazards are not as extensively identified across NRAs, despite the potential severity of their impact and/or likelihood of occurrence: in the case of earthquakes and forest fires, Southern European countries are substantially more vulnerable due to specific geographical and climatic characteristics; high level standards and control measures may reduce the risk of certain accidents (nuclear and transport for example);

[199] Joint Programming Initiative on Antimicrobial Resistance (JPIAMR), http://www.jpiamr.eu/.

finally, the risks of threats such as cyber and terrorist attacks have been so far difficult to assess due to the relatively recent appearance of these risks in most if not all European countries.

The cross-border dimension of the risks is central to the purpose of this overview and is clearly underlined across the NRAs received. The hazards addressed in this document present cross-border risks due to their geographical nature (earthquakes, fires, severe weather and floods), as well as the volatility and scale of their impacts (pandemics, livestock epidemics, nuclear/industrial accidents). The human, economic or environmental impacts of these hazards, as well as their likelihood of occurrence exist irrespective of national borders. In fact, the relevance of cross-border risks may extend beyond the borders of the EU, particularly so for countries in the Southern and Eastern Neighbourhoods[200]. Future versions of this overview will concentrate further on the cross-border dimension of the risks.

In line with the Council Conclusions and the Civil Protection legislation, this overview aims to take into account the likely impact of climate change on the risks assessed. Work carried out by Member States in their NRAs underlines the extent to which climate change constitutes a threat multiplier and the importance of climate adaptation and increasing resilience: either directly or indirectly, fast and slow-onset environmental degradation increase the likelihood (transport accidents, industrial accidents, etc.) as well as the impacts (floods, forest fires, severe weather, etc.) of the hazards assessed. In fact, NRAs make reference to the potential increasing severity and likelihood of non-natural hazards as a result of more extreme natural disasters due to climate change and ecosystem degradation. The overview explores the impact of climate change and ecosystem degradation as an emerging risk, its relevance to the hazards assessed and the work carried out at European level to address this emerging trend. The emerging risk of space weather, which relatively few Member States have discussed, deserves to be highlighted as an emerging risk the EU may face in the future.

Finally, complementary to the analysis carried out in this document, overviews of the state of progress of Member States' risk assessments, the methodology and criteria used in national risk assessments as well as a summary of national scores for each hazard risk are provided in annex.

The following steps are important in further developing a comprehensive EU overview of risks and further cooperation between Member States in disaster prevention and preparedness:

Data availability:

- Of 32 participating countries to the Mechanism for Civil Protection, 18 have contributed to this exercise. The submission of NRAs from Member States yet to contribute, as well as updates to submitted NRAs and progress reports will help complete a comprehensive EU overview of risks.
- Of the 18 contributions to this overview, nine Member States have provided information on national assessment criteria and scenario-building. More systematic and complete information on the assessment criteria and on the risk scenarios assessed may help the Commission carry out an informed and coherent analysis of risks addressed in NRAs.

[200] The impact of the 2010 volcanic eruption in Iceland on European airspace offers a telling example.

- Quantitative analysis of the data provided is not usually possible when it concerns risks of fundamentally different types. Concerning the same risk in different countries' NRAs, quantitative analysis is a challenge, but some quantitative comparison can be done. Analysis is needed to resolve the differences in the scenarios considered, in the methodological approach, and in the underlying classifications of likelihood and impact (see annexes 4 & 5). In view of future versions of this overview and once sufficient data is available in NRAs, a pan-European scenario and matrix for each hazard could be conceived. As suggested by Member States, pan-European scenarios could build on the scenario-building approach undertaken in national assessments and allow this overview to concentrate its attention on risks with a cross-border dimension. Potential new areas of cooperation could be explored. Below is an example of risk matrix for pandemic risk using currently available data and taking due note of differences in the scoring of impact and probability, as well as the scenarios and timeframes used for assessment, from one Member State to the next (see annex 4):

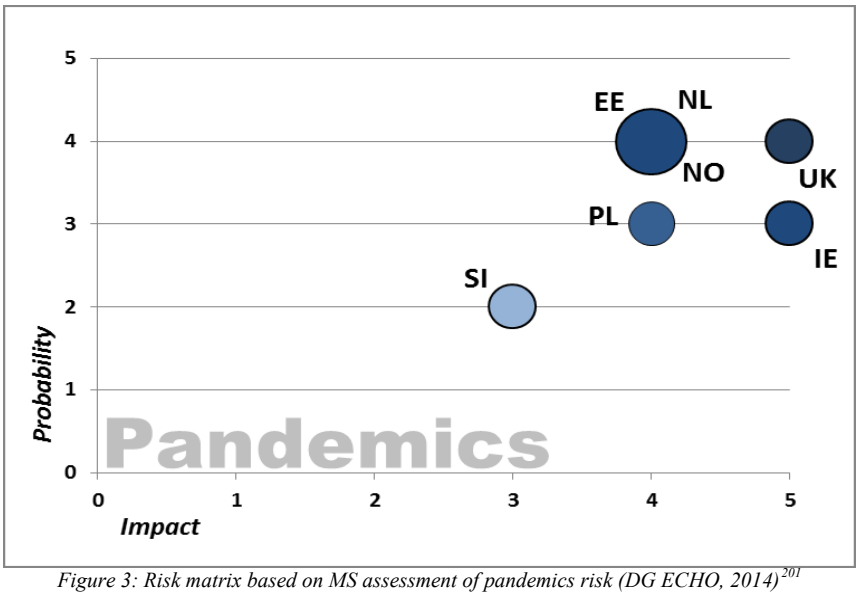


Figure 3: Risk matrix based on MS assessment of pandemics risk (DG ECHO, 2014)[201]

Links to other policy initiatives:

- All of the risks addressed in this overview are of relevance to various other policy areas. The nature and scope of the hazards addressed require cooperation at national, European and international levels in climate change adaptation, environment, health, agriculture, energy, transport, industry, security and defence, maritime policy and research policies. In addition, the cascade effects of each of these hazards reaffirm the need for cross-sectorial approaches to disaster risk management.
- The analysis of these hazards highlights climate change and ecosystem degradation as threat multipliers. The link between climate change, ecosystem degradation and the increasing severity and occurrence of natural disasters as well as the likelihood of most non-malicious man-made disasters is clear. To avoid the most serious risks of climate change and in particular large-scale irreversible impacts, global warming must be limited to below 2ºC above pre-

[201] This risk matrix has been compiled by the Commission using data available in National Risk Assessment risk matrices and interpreted by the Commission.

industrial level. Healthy ecosystems play a major role to achieve this objective. Climate change adaptation, including technological and natural solutions, and a better understanding of the impacts of climate change on disasters will be central to further work and cooperation on disaster prevention and preparedness. It is of particular importance to ensure joint approaches and full coherence between national adaptation strategies, national biodiversity strategies and national risk management plans.

- The identification of emerging risks – impact of climate change and ecosystem degradation, space environmental hazards and antimicrobial resistance – whose level of risk may justify their assessment in future work on risk assessment. These emerging risks will require new areas of cooperation amongst Member States and beyond.
- All of the risks explored in this overview have, to a greater or lesser extent, a cross-border dimension. This characteristic justifies the need for further cooperation beyond the national level. The Baltic and Danube initiatives are examples of regional projects through which several countries are cooperating in the field of DRM. In the Atlantic Strategy for example, risk management was identified as one of its priorities and addressed through specific cross-border projects. Further cooperation at an international level with other relevant actors active in disaster prevention and preparedness (OECD, UN, etc.) also seems appropriate.

Next steps:

- The cross-sectoral dimension of this overview and the risk assessments analysed will help contribute *inter alia* to the work of the Civil Protection Mechanism – particularly with regards the establishment by the Commission, under Article 5 of the Civil Protection legislation, of a cross-sectoral overview and map of natural disaster risks the Union may face[202] – and risk management capability. The overview will also contribute to the implementation of EU cohesion policy and to the Commission/EEAS proposal, within the legal framework of the Solidarity clause, for the regular production by the Commission and the High Representative of a joint integrated threat and risk assessment report at Union level as of 2015 in looking more closely into potential areas of cooperation in risk management, and can provide background information for the "Integrated Situational Awareness and Analysis" (ISAA) reports.
- The Commission will continue to welcome contributions by Member States on national risk assessments, both in the form of first contributions and updates to work being carried out at national and regional level. The Commission will integrate new information and material into subsequent versions of the overview.

[202] Decision No 1313/2013/EU, 20.12.2013, *op.cit.,* Article 5.

8 ANNEXES

Annex 1: Characteristics of National Risk Assessments (DG ECHO, 2014)

Country	No. of risks	Complete document	Risk selection criteria	Scenario	Matrix available	Time-frame
BG	5	NO	-	NO	NO	N/A
CY	5	NO	-	NO	NO	N/A
CZ	3	NO	A risk analysis is prepared for the regional level and is focused on the risks which could lead to an emergency or crisis situation. Crisis situation analysis is based on predefined 23 types of possible crisis situations	NO	NO	N/A
DE	18[203]	NO	Scenarios are selected according to the criteria 'nationally relevant' and 'reasonable worst case'	NO	NO	N/A
DK	10	YES	Impacts should be very considerable in terms of magnitude, geographical scope and duration. Focus on national level as impacts manifested within borders;	NO	relative placing of event types in national picture of impacts only	N/A
EE	26	YES	Based on Emergency Act: Event, or chain of, which endangers the life or health of many people or causes significant property damage or significant environmental damage or severe and extensive disruptions in the continuous operation of vital services, which requires a prompt and coordinated response from several agencies;	NO	relative placing of event types in national picture	1 YEAR
EL	6	NO	Any situation which has or may have an adverse impact on people, the environment or property and which may result in a call for assistance under the Civil Protection Mechanism;	NO	NO	1 YEAR
HU	8	NO	-	NO	For natural weather hazards only	N/A
IE	26	YES	Identification of generic hazards, falling into four categories: natural, transportation, technological and civil;	NO	relative placing of event types in national picture	N/A
IT	4	NO	Focus on natural events that affect a large number of individuals, producing effects on a generality	YES	NO	N/A

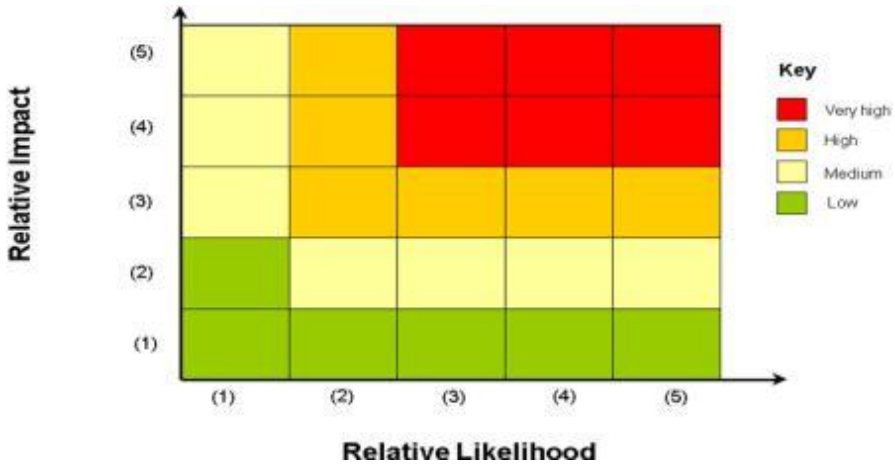
[203] Non-exhaustive list that will be complemented over time

			of persons and, therefore, can only be called public;			
LT	11	YES	Events causing negative consequences on human lives, health, and property including cultural heritage and environment. Natural, technological, ecological, social and other hazards causing disasters at national level (exceeding limits of territory of 3 municipalities). Possible negative impact on neighbouring countries;	YES	3 matrices for each impact assessed	N/A
NL	39	YES	In addition to risks assessed in previous NRAs (2007, 2008, 2009), risks identified through the National Safety and Security Strategy. Scenarios identified to assess hazards that can potentially affected NL;	YES for 7 hazards	YES	N/A
NO	9 natural incidents, major accident; intentional incidents	YES	Risk associated with major undesirable - with negative consequences for basic societal values - incidents that could affect NO. Five fundamental values include; life and health; nature and environment; economy; social stability; sovereignty;	YES	YES for each category	N/A
PL	18 natural hazards, major accidents and civil hazards	YES	Defined by major influence on functioning and development possibilities of nation. Effects can harm national security, pose threats to considerable number people's lives, health, property and environment in sizeable territory; can have an extraterritorial dimension;	YES	relative placing of event types in national picture	2 YEARS
RO	10	NO	-	NO	NO	N/A
SE	27	YES	Focus on events that have low likelihood but that could have serious impacts if they do occur; each scenario threatens at least one national protection value and are designed to be of the worst probable type;	YES (7)	YES	1 YEAR
SI	24	NO	Disasters which affect the entire or parts of the national territory. Focus on disasters already assessed and/or regional/local response plans and on reasonable worst case scenarios;	NO	YES (13)	N/A
UK	80	YES	Risks identified in consultation with government departments and stakeholders; must be plausible and in non-malicious cases, have at least 1/20,000 chance of occurring; present challenge to national government;	YES	YES one malicious, one non-malicious	5 YEARS

Annex 2: Risk Matrix

As suggested in the risk assessment and mapping guidelines produced by the Commission, a number of Participating States assessed the level of risk for each hazard identified using a risk matrix. According to the guidelines, a risk matrix measures risk levels on the basis of impact and likelihood using a 5x5 scale: risk matrices "help to define which risks need further or more detailed analysis or which given risk is considered broadly acceptable or not acceptable, according to the zone where it is located on the matrix"[204]

Template of risk matrix provided in the guidelines:



Four levels of risk are identifiable – very high (red); high (orange); medium (light yellow); low (green) – according the relative placing of a risk on the graph. Comparability of each risk between the different Member States is rendered difficult due to varying terminology, measurement methodology, time scale, etc. An attempt at contrasting the relative assessments of risks based on matrix assessment for each risk will provide guidance on risks of importance and thus needing further or more detailed analysis for the respective Participating State.

Annex 3: Summary of results of risk assessments carried out by Participating States using the grading of risk level identified in the matrix above (DG ECHO, 2014)

Country	Level			
	Very High	**High**	**Medium**	**Low**
CZ	Floods, severe weather, chemical accidents	Epidemic, epizootic, critical infrastructure disruption, energy shortage	Nuclear accident, financial crisis, landslides, lack of food and water	Earthquakes, immigrations
EE	- Large-scale marine pollution; - Large-scale coastal pollution; - Large-scale inland ground, surface water or ground water pollution; - Epidemics; - Large-scale cyber-	- Large-scale forest and landscape fires; - Large-scale fires or explosion in industrial buildings or warehouses; - Fires, explosions or collapses which injure many people; - Extensive health	- Highway accidents with a large number of victims; - Aircraft accidents with a large number of victims; - Passenger train accidents with a large number of victims; - Accidents with trains	- Extremely hot weather; - Extremely cold weather; - Massive immigration of refugees into the states.

[204] European Commission, SEC(2010) 1626 final, op.cit.,p.18

	attacks;	damage and deaths caused by ice formation or melting; - Passenger ship accidents with a large number of victims; - Mass poisoning; - Storms; - Flooding in densely populated areas; - Mass disorder; Epizootics; Mass disorder in prisons.	transporting hazardous substances, resulting in a large number of victims or great damage to the natural environment; - Radiation emergencies with domestic causes; - Cross-border nuclear accidents.	
HU	-	- Hurricane-like wind; - Stormy winds; - Rain; - Heat wave.	- Extremely hot weather; - Extremely cold weather.	-
IE	- Floods; - Cyber incident.	- Drought; - Snow; - Volcanic ash; - Storm; - High temperatures; - Low temperatures; - Air accident; - Maritime accident; - Road accident; - Rail accident; - Transport hub; - Loss Critical Infrastructure; - Infectious diseases; - Animal diseases; - Crowd safety; - Public disorder; - Disruption to Energy Supply; - Hazmat; - Fire; - Nuclear (abroad); - Terrorist activity.	- Radiation (domestic); - Water borne outbreak; - Flood borne outbreak.	-
LT	- Harmful mechanisms; - Drought; - Natural and catastrophic meteorological phenomena; - Flood; - Epidemics and/or pandemics; - Chemical accidents.	- Epizootics; - Pollution with radioactive materials; - Cyber-attacks.	- Hazardous radioactive find; - Other radiological accidents and events; - Events at sea; - Nuclear accidents.	-
NL	- Cyber-espionage; - Cyber-conflict; - IP network failure (ICT); - Manipulation of public administration; - Severe influenza pandemic; - Malicious prolonged	- Satellite disruption due to solar storm; - Severe snowstorm; - Black ice; - National power failure; - Malicious power supply failure; - Response to	- Unrest regarding Salafism; - Mild influenza pandemic; - Worst-credible coastal flood; - Nuclear incident; - Rhine Ijssel flood - Shipping accident;	- Manipulation of share market; - Left-wing extremism.

	electricity failure; - Geopolitical oil supply crisis; - Mineral shortages.	exogenic jihadist threat; - Muslim extremism; - Crisis outside the EU; - Animal rights extremism; - Unrest in problem neighbourhoods; - Confrontation between ethnic minorities and extreme right.	- Chemical accident; - Malicious gas supply failure; - Very severe storm; - Wildfire; - Extreme heat and drought; - Food shortages; - Animal rights activism; - Rail crash.	
NO	- Influenza pandemic.	- Nuclear accident; - Storm; - Energy shortage; - Landslide.	- Security policy crisis; - Cyber-attack (financial); - Terrorist attack; - Ship collision.	- Gas leak.
PL		- Floods;	- Epidemics; - Chemical contamination; - Disruption of electricity supplies; - Disruption of fuel supplies; - Disruption of natural gas supplies; - Heavy snow; - Storms; - Forest and wildfires; - Epizootics; - Plant diseases (epiphytotic); - Construction disasters; - Droughts; - Nuclear/radiological accident; Social disorder	- Low temperatures
SE[205]	- Prolonged heat wave; - Failure of a large dam on a river; - Disruption in the food supply due to fuel shortages; Major fire on a cruise ship.	- School shooting.	- Extensive disruption to GNSS.	- Disruption to the drinking water supply due to diesel discharge in Stockholm's raw water.
SI	-	- Flood; - Earthquake.	- Pandemic; - Aircraft accident; - Accident at sea; - Accident involving dangerous substances; - Drought; - Nuclear accident;	- Storm; - Large-scale forest fire;

[205] The key for risk levels are an interpretation by the European Commission of Sweden's risk matrix

			- Rail accident; - Massive motorway accident including tunnel accident; - Outbreak of dangerous animal diseases.	
UK	- Pandemic influenza; - Coastal flooding; - Effusive volcanic. eruption	- Major industrial accidents; - Other infectious diseases; - Inland flooding; - Severe space weather; - Low temperatures and heavy snow; - Heat wave; - Catastrophic terrorist attacks; - Cyber-attacks: infrastructure; - Attacks on infrastructure; - Smaller-scale CBR attacks; - Attacks on crowded places; - Attacks on transport systems.	- Major transport accidents; - Animal diseases; - Drought; - Public disorder; - Explosive volcanic eruption; - Storms and gales.	- Severe wildfires; - Disruptive industrial action; - Cyber-attacks: data confidentiality.

Identified hazards for which risks are not (yet) assessed using a 5x5 risk matrix / assessment not provided:

Country	Hazards
BG	Earthquakes; floods; nuclear/radiological accidents; geological hazards; forest fires
CY	Forest fires: earthquakes; extreme weather conditions; extensive droughts and pandemics
DE	Animal disease; cold wave; crop pathogens/vermin; drought; extra-terrestrial hazards (solar storm, meteorite impact, space debris); heat wave; heavy precipitation; low water; outage of critical infrastructure; release of biological substances; release of chemical substances; release of radioactive substances; seismic events; storm surge; wild fire (in alphabetical order)
DK	Severe weather (hurricanes, floods, etc.); pandemic; livestock epidemic; transport accident; hazmat accident; marine pollution; nuclear accident; terrorist attack; cyber-attack
EL	Earthquakes; tsunamis; landslides; wildfires; floods; industrial accidents
HU	Floods; earthquakes; forest fires; industrial accidents; mass-events; terrorism; immigration; livestock epidemics
IT	Floods; landslides; volcanic eruptions; earthquakes
PL	Terrorist threats; landslides
RO	Floods; wildfires; droughts; earthquakes; landslides; pandemics; livestock epidemics; nuclear accidents; industrial/chemical accidents

Annex 4: Impact/probability assessment in NRAs (DG ECHO, 2014)

Annex 4(a): Impact/consequences criteria

Country	Level				
BG	-	-	-	-	-
Criteria					
CY	-	-	-	-	-
Criteria					
CZ	**0**	**1**	**2**	**3**	**4**
Criteria	No impact	< 10 victims < 500m2 1 building	< 100 victims < 1ha > 1 building	< 1000 victims < 1km2 Part of the city	> 1000 victims > 1km2 City or region
DE	-	-	-	-	-
Criteria					
DK	**Serious**	-	**Very serious**	-	**critical**
Criteria	-		-		-
EE	**A - Insignificant**	**B - Light**	**C - Serious**	**D - Very serious**	**E - Catastrophic**
Criteria	*human: individual seriously or lightly injured persons;*	*human: Up to 30 seriously injured requiring hospital care;*	*human: Some fatalities. 31-170 injured needing care - beyond regional intervention;*	*human: Tens of fatalities. 171-400 injured needing care. National resources required.*	*human: Many tens of fatalities. Over 400 injured needing care. International resources required;*
	Assets: no or light property damage €0-575,204.84;	*Assets: €639,116.49-3,131,670.80;*	*Assets: €1,278,233-5,106,540.70;*	*Assets: €1,278,233-5,106,540.70;*	*Assets: Foreign assistance necessary. Expenses over 0.5% of GDP;*
	Natural environment: no measurable change in species or ecosystem functions;	*Natural environment: changes at scene in population levels and ecosystem function. Returns to normal without intervention;*	*Natural environment: Changes at scene in population of one or more species and ecosystem function. Intervention required;*	*Natural environment: Major changes at scene. Status quo very hard to restore;*	*Natural environment: Living habitats and ecosystem at scene destroyed. Impossible to restore previous situation;*
	Vital service: temporary disruptions, no direct losses;	*Vital service: short-term disruptions in functioning of service;*	*Vital service: More than 1 daily disruption. Backup systems necessary;*	*Vital service: Non-functioning of service significantly reduces security of society;*	*Vital service: Service/field completely ceased to function;*
EL	**Limited**	**Minor**	**Moderate**	**Significant**	**Catastrophic**
Criteria	*Less than 'minor' effects*	*Human: injuries and/or illnesses do not result in permanent disability*	*Human: injuries and/or illness do not result in permanent disability*	*Human: injuries and/or illnesses result in permanent disability*	*Human: multiple deaths*
		Vital service: shutdown for 24 hours or less	*Vital service: complete shutdown for more than 1 week*	*Vital service: complete shutdown for at least 2 weeks*	*Vital service: complete shutdown for 30 days or more*
		Property: less	*Property: more*	*Property: more*	*Property: more*

		than 10% severely damaged	*than 10% severely damaged*	*than 25% severely damaged*	*than 50% severely damaged*
HU	**Low**	**Not severe**	**Severe**	**Very severe**	
Criteria	*Event not causing injuries requiring medical assistance, and not leading to financial consequences - (fires: below 1 ha)*	*Event causing mild injuries, not associated with environmental damages, or leading to minor financial consequences - (fires: 1-10 ha)*	*Events causing serious injuries or reversible environmental damages or leading to financial consequences - (fires: 10-100 ha)*	*Events causing fatal victims or irreversible environmental damages or leading to financial consequences - (fires: over 100 ha)*	-
IE	**1 - Very low**	**2 - Low**	**3 - Moderate**	**4 - High**	**5 - Very High**
Criteria	*Human: limited number of people affected; 0-4 fatalities and limited number of minor injuries requiring first aid treatment*	*Human: 4-8 fatalities; considerable number of people affected; serious injuries with hospitalisation and medical treatment required. Localised displacement of a considerable number of people for 2-8 days. Personal support satisfied through local arrangements*	*Human: significant number of people in affected area impacted with multiple fatalities (8-20), multiple serious or extensive injuries (20), significant hospitalisation. Large number of people displaced for 2-8 days; up to 4,000 evacuated*	*Human: 20 to 50 fatalities, up to 100 serious injuries, up to 16,000 evacuated*	*Human: Large numbers of people impacted with significant numbers of fatalities (50+), significant injuries in the hundreds, more than 16,000 evacuated*
	Environment: simple, localised contamination	*Environment: simple, regional contamination, effects of short duration*	*Environment: Heavy contamination localised effects or extended duration*	*Environment: Heavy contamination, widespread effects or extended duration*	*Environment: Very heavy contamination, widespread effects of extended duration*
	Infrastructure: less than €4million	*Infrastructure: €4-24 million*	*Infrastructure: €24-80 million*	*Infrastructure: €80-200 million*	*Infrastructure: €200 million +*
	Social: localised disruption to community services or infrastructure (less than 48hrs)	*Social: Community functioning with considerable inconvenience*	*Social: Community only partially functioning, some services available*	*Social: Community functioning poorly, minimal services available*	*Social: Serious damage to infrastructure causing significant disruption to, or loss of, key services for prolonged period. Community unable to function without significant support*
IT	-	-	-	-	-
Criteria					
LT	**1 - insignificant**	**2 - limited**	**3 - high**	**4 - very high**	**5 - catastrophic**

Criteria	*Human: no more than 10 fatalities, more than 50 injured. No need for evacuation*	*Human: 10 to 20 fatalities, 50 to 100 injured; up to 300 evacuated*	*Human: 20 to 50 fatalities; 100 to 250 injured; 300 to 1,000 evacuated*	*Human: 50 to100 fatalities; 250 to 500 injured; 1,000 to 2,000 evacuated*	*Human: more than 100 fatalities; more than 500 injured; more than 2,000 evacuated*
	Economic/environmental: up to 0.35% of GDP	*Economic/environmental: 0.35% to 0.9% of GDP*	*Economic/environmental: 0.9% to 1.75% of GDP*	*Economic/environmental: 1.75% to 2.6% of GDP*	*Economic/environmental: more than 2.6% of GDP*
	Political/social: assemblies of up to 1,000 people; non-disruptive meetings; disturbances of supply or outage of energy at municipal level; strikes not causing consequences; sector activities disrupted for up to 6hrs; traffic stopped for up to 3 days	*Political/social: assemblies of 1,000 to 5,000 people; meetings causing upheaval and nuisances and disturbance of supply or outage of energy in up to 3 municipalities; strikes not causing consequences; sector activity disrupted 6 to 24hrs; traffic disrupted up to 10 days*	*Political/social: assemblies 5,000 to 10,000; meeting causing upheaval and nuisance in 3 to 5 municipalities; disturbance of supply or outage of energy in no more than 1/3 of territory; strikes not causing consequences; sector activities disrupted for 1 to 3 days; traffic disrupted for up to 20 days*	*Political/social: assemblies 10,000 to 20,000; meetings causing upheaval and nuisances in 5 to 10 municipalities; disturbance to supply or outage of energy no more than 2/3 of territory; strikes causing consequences; sector activities disrupted for 3 to 30 days; traffic disrupted up to 40 days*	*Political/social: assemblies 20,000 to 30,000; meetings causing massive upheavals and nuisance in more than 10 municipalities; disturbance of energy or outage of energy in more than 2/3 of territory; strikes with consequences on residents and authorities; sector activity disrupted for more 30 days; traffic disrupted for more 40 days*
NL	**A - Limited**	**B - Substantial**	**C - Serious**	**D - Very serious**	**E - Catastrophic**
Criteria	*-*	*3xA*	*3xB*	*3xC*	*3xD*
NO	**A - Very low**	**B - Low**	**C - Medium**	**D - High**	**E - Very High**
Criteria	*-*	*3xA*	*3xB*	*3xC*	*3xD*
PL	**A – irrelevant**	**B – small**	**C – medium**	**D – large**	**E – disastrous**
Criteria	*Life and Health: No fatalities or injured people; no one or small number of people displaced for short period of time (up to 2hrs); no one or small number of people need help (no financial or material help)*	*Life and Health: small number of injured people but no fatalities; first aid required; necessary displacement of people (less than 24hrs); some people need help*	*Life and Health: Medical help needed but no fatalities; some people require hospitalization; extra space in hospitals and additional medical personnel needed; evacuated people staying in the designated areas with possibility of return within 24hrs*	*Life and Health: badly injured; a lot of people hospitalized; a large number of people displaced (for more than 24hrs); fatalities; need for specific resources to help people and to remove the damage*	*Life and Health: large number of seriously injured; large number of hospitalized; general and long-term displacement of populations; large number of fatalities; enormous help to a considerable number of people required*
	Property: virtually no damage; None of very little	*Property: some damage; some obstacles (no longer than*	*Property: determination of the damage sites, which*	*Property: community partially functioning, some*	*Property: extensive damage; community inability to*

	impact on local community; little or no financial loss	*24hrs); slight financial loss; no additional funds required*	*require routine repair; normal functioning of the community with minor inconveniences; considerable financial loss*	*services are unavailable; large financial losses; help from the outside needed*	*function without significant external assistance*
	Environment: imperceptible effect on the natural environment	*Environment: little impact on the natural environment for short-term effect*	*Environment: some effects on the natural environment but short-term or small effects with long-lasting effects*	*Environment: long-term effects on the environment*	*Environment: large impact on the environment and/or permanent damage*
RO	-	-	-	-	-
Criteria					
SE	**Limited**	**Substantial**	**Serious**	**Very serious**	**Catastrophic**
Criteria	*Human: <5 deaths and/or <25 severely injured*	*Human: 5-29 deaths and/or 25-99 severely injured*	*Human: 30-99 deaths and/or 100-499 severely injured.*	*Human: 100-500 deaths and/or 500-2500 severely injured*	*Human: >500 deaths and/or >2500 severely injured*
	Economic/environmental: <50 million SEK	*Economic/environmental: 50-500 million SEK*	*Economic/environmental: 0.5-5 billion SEK*	*Economic/environmental: 5-50 billion SEK*	*Economic/environmental: >50 billion SEK*
	Political/social: limited	*Political/social: substantial*	*Political/social: serious*	*Political/social: very serious*	*Political/social: catastrophic*
SI	**1**	**2**	**3**	**4**	**5**
Criteria	-	-	-	-	-
UK	**1 - Limited**	**2 - Minor**	**3 - Moderate**	**4 - Significant**	**5 - Catastrophic**
Criteria	*Impact criteria: economic; fatalities; casualties; social disruption; psychological*				

Annex 4(b): Probability/likelihood criteria

Country	Level				
BG	-	-	-	-	-
Criteria					
CY	-	-	-	-	-
Criteria					
CZ	**1**	**2**	**3**	**4**	**5**
Criteria	Occurs less than once in 1000 years	Occurs once in 100 – 1000 years	Occurs once in 10 – 100 years	Occurs once in 1 – 10 years	Occurs more than once in 1 year
DE	-	-	-	-	-
Criteria					
DK	-	-	-	-	-
Criteria					
EE	**1- Very low**	**2 - Low**	**3 - Medium**	**4 - High**	**5 - Very High**
Criteria	*Probability within 1 year: 0.005% to 0.05%*	*Probability within 1 year: 0.05% to 0.5%*	*Probability within 1 year: 0.5% to 5%*	*Probability within 1 year: 5% to 50%*	*Probability within 1 year: 50% +*
EL	**E - Extremely unlikely but yet possible**	**D - Highly unlikely**	**C - Unlikely**	**B - Likely**	**A - Highly likely**

Criteria	*Probability within 1 year: less than 0.001%*	*Probability within 1 year: 0.001% to 0.01%*	*Probability within 1 year: 0.001% to 0.01%*	*Probability within 1 year: 0.01% to 0.1%*	*Probability within 1 year: more than 1%*
HU	**Rare**	**Uncommon**	**Common**	**Very Common**	
Criteria	*Unlikely to occur in the next few years (10 years) - (fires: less than once a year)*	*May occur, but is unlikely to occur within a few years (5 years) - (fires: 1-3 times a year)*	*Likely to occur within 1 year - (fires: 4-25 times a year)*	*Highly likely to occur at least once within a year - (fires: over 25 times a year)*	-
IE	**1 - Extremely unlikely**	**2 - Very unlikely**	**3 - Unlikely**	**4 - Likely**	**5 - Very likely**
Criteria	*May occur only in exceptional circumstances: once every 500+ years*	*Is not expected to occur; and/or no recorded incidents or anecdotal evidence; and/or very few incidents in associated organisations, facilities or communicates; and/or little opportunity, reason or means to occur; May occur once every 100-500 years*	*May occur at some time; and/or few, infrequent, random recorded incidents or little anecdotal evidence; some incidents in associated or comparable organisations worldwide; some opportunity, reason or means to occur; may occur once per 10-100 years*	*Likely to or may occur; regular recorded incidents and strong anecdotal evidence and will probably occur once per 1-10 years*	*Very likely to occur; high level of recorded incidents and/or strong anecdotal evidence. Will probably occur more than once a year*
IT	-	-	-	-	-
Criteria					
LT	**1 - very low**	**2 - low**	**3 - medium**	**4 - high**	**5 - very high**
Criteria	*Less than once in 100 years*	*Once in 50 to 100 years*	*Once in 10 to 50 years*	*Once in 1 to 10 years*	*More often than once a year*
NL	**1 - Highly unlikely**	**2 - Unlikely**	**3 - Moderately likely**	**4 - Likely**	**5 - Highly likely**
Criteria	*-*	*10x1*	*10x2*	*10x3*	*10x4*
NO	**A - Very low**	**B - Low**	**C - Medium**	**D - High**	**E - Very High**
Criteria	*non-intentional event: more than once per 100,000 years: 0-0.05%* *intentional event: no threat*	*non-intentional event: more than once per 10,000 years: 0.05-0.5%* *intentional event: possible but not probable threat*	*non-intentional event: more than once per 1,000 years: 0.5-5%* *intentional event: possible threat*	*non-intentional event: more than once per 100 years: 5-50%* *intentional event: general and unspecified threat*	*non-intentional event: more than once per 10 years: 50-100%* *intentional event: specific and immediate threat*
PL	**1 – very rare**	**2 – rare**	**3 – possible**	**4 – likely**	**5 – very likely**
Criteria	*May occur only in exceptional circumstances: 1 in 500 years or even more rarely*	*Not expected to happen and not documented and does not exist in human communications; minimal chance, reason, or other circumstances that the events*	*May happen within a certain timeframe; rarely random events that are transmitted/documented orally; very few events; chance, reason of facility*	*Likely it will occur in most circumstances; events systematically recorded and communicated in the oral form; considerable chance, reason*	*Expected to happen in most circumstances and/or events are very well documented and/or they operate among the population and are*

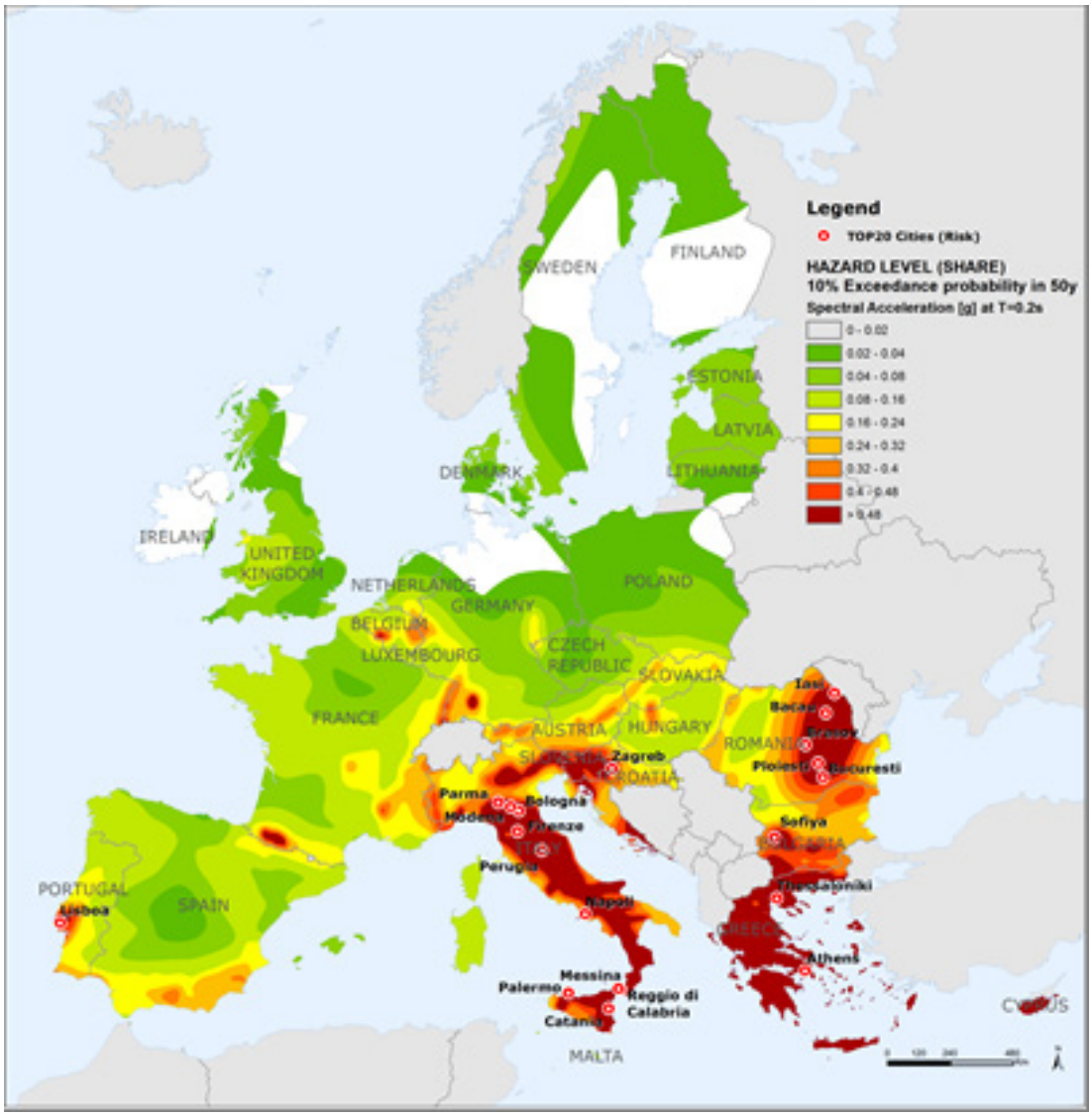
		could occur: 1 in 100 years	*allowing it to occur; 1 in 20 years*	*of facility allowing it to occur; 1 in 5 years*	*transmitted orally; Once a year or more*
RO					
Criteria	-	-	-	-	-
SE	**Very low**	**Low**	**Medium**	**High**	**Very high**
Criteria	*≤0.0001 on a yearly basis (≤1 in 10,000 years)*	*0.0001 – 0.001 on a yearly basis (1 in 9,999 years – 1 in 1,000 years)*	*0.001 – 0.01 on a yearly basis (1 in 999 years – 1 in 100 years)*	*0.01 – 0.1 on a yearly basis (1 in 99 years – 1 in 10 years)*	*>0.1 on a yearly basis (>1 in 10 years)*
SI	**1**	**2**	**3**	**4**	**5**
Criteria	-	-	-	-	-
UK	**1**	**2**	**3**	**4**	**5**
Criteria - threats	*Low*	*Medium-low*	*Medium*	*Medium-high*	*High*
Criteria - hazards	*Between 1 in 20,000 and 1 in 2,000*	*Between 1 in 2,000 and 1 in 200*	*Between 1 in 200 and 1 in 20*	*Between 1 in 20 and 1 in 2*	*Greater than 1 in 2*

Annex 5: Synthesis of scores allocated (DG ECHO, 2014)

	BG		CY		CZ		DE		DK		EE		GR		HU		IE		IT		LT		NL		NO		PL		RO		SE		SI		UK	
	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.	Imp.	Prob.
Floods	*				*		*				*		*				*		*		*		*		*		4	4	*		*		*		*	
coastal																	4	4	*				5	1											4	3
inland					*						3	3					4	4	*				4	1							*		3	3	3	3
Severe weather			*		*		*		*		*				*		*				*		*		*		*				*		*		*	
Storms					*		*		*		3	3			4	4	3	3			*		2	4	3	3	3	4					1	3	2	4
Heat waves							*				2	4			4	3	2	3					2	4							4	4	2	2	3	4
Cold waves							*																													
Snow/ice											2	2					2	4			*		3	5			3	4							3	4
Rain							*		*						4	2																				
Wildfires/forest fires	*		*				*				3	4	*				4	3					2	4			3	4	*				1.7	3	1	3
Droughts			*				*										4	3			*						2	3	*				2.7	2		
Earthquakes	*		*		*		*						*		*				*										*				4	2		
Tsunamis													*																							
Landslides	*				*								*						*						3	3			*							
Volcanos/volc. ash																	4	3	*																4	3
Pandemics/Epidemics			*		*		*		*		4	4					5	3			*		4	4	4	4	4	3	*		*		3	2	5	4
Livestock epidemics					*		*		*		3	3			*		4	3			2	4					3	3	*		*		2	2	2	3
Harmful organisms							*														*						3	3								
Environmental pollution											*																									
Marine/coastal pollution											4	4									1	3														
Water contamination											4	3					4	2													2	1				
Food contamination																	4	2													*					
Loss of critical infrastructure					*		*										5	3			1	4	4	3	3	3	3	3			5	3			3	3
Nuclear/Radioactive accidents	*				*		*		*		4	1			*		4	3			2	1	4	1	3	2	3	2	*		*		4.3	1		
Industrial/chemical accidents					*		*				4	2	*		*		4	3			*		3	1			4	3	*				2.3	2	4	4
Terrorist attacks									*								4	3					3	2	2	2	*				*				5	2
CBRN attacks																															*				3	3
Cyber-attacks									*		4	4			*		4	4			*		4	4	2	2	5	5							1	5
Public Disorder											3	3					3	3									2	4			3	4			2	4
Refugees					*						2	3			*																					
Transport accidents									*		*				*		*				*		*		*						*		*		*	
danger. subs.									*						*		4	3			*				1	1			*				2	2		
land											3	2					3	3															2	2	3	2
sea									*		5	2					4	3			1	3	3	1	2	2					*		2.3	2	3	2
air											5	1					4	3															2.3	2	3	2
Space weather							*																3	3							*				3	4

*Legend: * indicate hazards identified but not assessed*

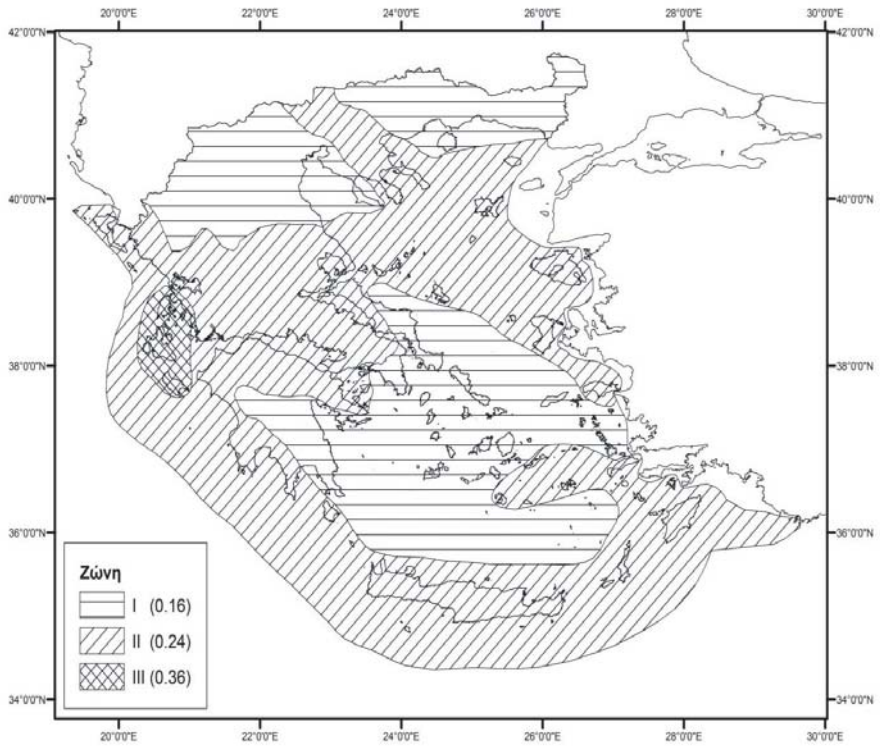
Annex 6: Top 20 European cities at risk of human losses for earthquakes. Risk is defined as the product of the percentile of the population (for 4,500 cities exceeding 50,000 people) and the percentile of Spectral Acceleration at T=0.2s for those cities. (SHARE, JRC, 2013)



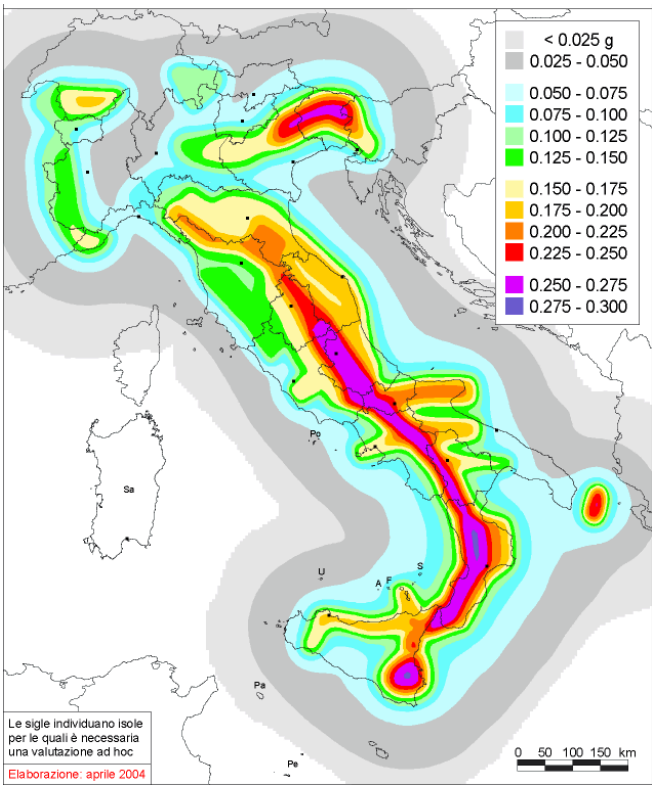
City (population > 50000)	Country	Population Source: LandScan	Spectral Acceleration at T=0.2s Source: SHARE	Population Percentile	Spectral Acc. 0.2s Percentile	Risk Percentile
Athens	Greece	761,919	0.7	0.993	0.978	0.971
Messina	Italy	245,059	0.8	0.962	0.993	0.955
Sofiya	Bulgaria	1,091,857	0.6	0.996	0.953	0.949
Catania	Italy	300,140	0.7	0.973	0.974	0.948
Napoli	Italy	977,046	0.6	0.995	0.951	0.946
Thessaloniki	Greece	352,658	0.6	0.978	0.962	0.941

Bologna	Italy	372,437	0.6	0.981	0.955	0.937
Palermo	Italy	661,062	0.6	0.992	0.943	0.935
Reggio di Calabria	Italy	181,374	0.9	0.936	0.996	0.932
Zagreb	Croatia	686,771	0.5	0.992	0.931	0.924
Bacau	Romania	211,421	0.6	0.950	0.959	0.911
Bucuresti	Romania	1,840,470	0.5	0.998	0.908	0.906
Ploiesti	Romania	246,377	0.6	0.963	0.941	0.906
Firenze	Italy	367,988	0.5	0.981	0.920	0.903
Lisboa	Portugal	510,121	0.5	0.987	0.914	0.902
Modena	Italy	180,314	0.6	0.935	0.962	0.899
Iasi	Romania	351,965	0.5	0.978	0.919	0.899
Brasov	Romania	303,874	0.5	0.973	0.923	0.898
Perugia	Italy	157,718	0.7	0.917	0.976	0.895
Parma	Italy	174,469	0.6	0.931	0.957	0.891

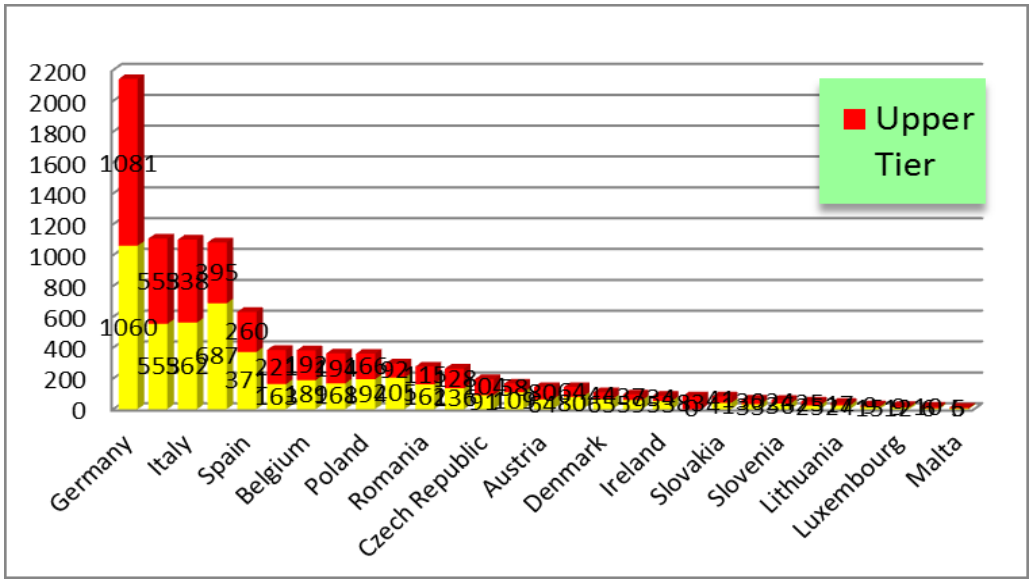
Annex 7: Earthquake hazard in Greece (Greek NRA)



Annex 8: Italian earthquake hazard map from 2004 (Italian NRA)



Annex 9: Upper and lower tier establishments per country (JRC, 2012)



9 BIBLIOGRAPHY

- Alfieri L., et al., Advances in pan-European flood hazard mapping, *Hydrological Processes*, 2013.
- ANTIGONE Project (ANTIcipating the Global Onset of Novel Epidemics), www.antigonefp7.eu.
- ASTROM Project, JLS/2008/CIPS/018.
- Bank of England Financial Policy Committee, *Financial Stability Report Issue No. 33*, June 2013, available at: http://www.bankofengland.co.uk/publications/Documents/fsr/2013/fsrfull1306.pdf.
- Barredo J., Sauri D., "Floods", in EEA, "Mapping the impacts of the natural hazards", *European Environment Agency Technical Report no. 13/2010*, 2010, http://www.eea.europa.eu/publications/mapping-the-impacts-of-natural.
- Beck, M.W., Shepard C.C., "Coastal Habitats and Risk Reduction", *World Risk Report*, 2012, 32, available at: http://www.ehs.unu.edu/file/get/10487.pdf.
- Booz & Company, Study "evaluation of options for a space programme in 2014-2020", *Final report*, 16.5.2011, contract n. ENTR/2009/050 lot 1.
- ClimateCost Project, http://www.climatecost.cc/.
- CORFU Project, http://www.corfu-fp7.eu/.
- Council Conclusions on the Communication An EU Strategy on adaptation to climate change, 11151/13, *Environment Council meeting*, Luxembourg, 18.6.2013.
- Council Conclusions on further developing risk assessment for disaster management within the European Union, *3081st Justice and Home Affairs Council meeting*, Brussels, 11.4.2011.
- Council Conclusions on a Community framework on disaster prevention within the EU, *2979th Justice and Home Affairs Council meeting*, Brussels, 30.11.2009.
- 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, *Official Journal of the European Union*, L (345), 23.12.2008.
- Council Directive 2005/94/EC of 20 December 2005 on Community measures for the control of avian influenza and repealing Directive 92/40/EEC, *Official Journal of the European Union*, L (167), 14.1.2006.
- Council 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, *Official Journal of the European Communities,* L (306), 22.11.2003.
- Council Directive 2001/89/EC of 23 October 2001 on Community measures for the control of classical swine fever, *Official Journal of the European Communities*, L (316), 1.12.2001.
- Council Directive 2001/55/EC on minimum standards for giving temporary protection in the event of a mass influx of displaced persons and on measures promoting a balance of efforts between Member States receiving such persons and bearing the consequences thereof, *Official Journal of the European Communities*, L (212), 7.8.2001.
- Council Directive 2000/75/EC of 20 November 2000 laying down specific provisions for the control and eradication of bluetongue, *Official Journal of the European Communities*, L (327), 22.12.2000.
- Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances, *Official Journal of the European Communities*, L (10), 14.1.1997.

- Council Directive 92/35/EEC of 29 April 1992 laying down control rules and measures to combat African horse sickness, *Official Journal of the European Communities,* L (157), 10.6.1992.
- Council Framework Decision of 13 June 2002 on combating terrorism (2002/475/JHA), *Official Journal of the European Communities*, L (164), 13.6.2002.
- Council of the EU, *Annual report on the implementation of the EU Counter-Terrorism Strategy: Evaluation by the CTC and questions for discussion,* 16471/12, Brussels, 23.11.2012.
- Council of the EU, *Adoption of the Council Conclusions on the Communication Strengthening chemical, biological, radiological and nuclear (CBRN) security in the European Union – an EU CBRN Action Plan*, 15505/1/09 REV1, Brussels, 12.11.2009.
- Council of the EU, *EU Action Plan on Enhancing the Security of Explosives*, 8311/08, Brussels, 11.4.2008.
- Council of the EU, *Resolution Taking forward the European Space Policy,* CS 13569/08, Brussels, 29.09.2008.
- Council of the EU, *The European Union Counter-Terrorism Strategy*, 14469/4/05, Brussels, 30.11.2005.
- Council Regulation (EC) No 2012/2002 of 11 November 2002 establishing the European Union Solidarity Fund, *Official Journal of the European Communities,* L (311), 14.11.2002.
- Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism, *Official Journal of the European Union,* L (347), 20.12.2013.
- Decision No 1082/2013/EU of the European Parliament and of the Council on serious cross-border threats to health and repealing Decision No 2119/98/EC, *Official Journal of the European Union*, L (293), 5.11.2013.
- Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Seventh Framework Programme of the European Community for Research, technological development and demonstration activities (2007-2013), *Official Journal of the European Union,* L (412), 30.12.2006.
- DEWFORA Project, http://www.dewfora.net.
- DORATHEA Project, HOME/2010/CIPS/AG/030.
- Directive 2012/18/EU of the European Parliament and of the Council on the control of major-accident hazards involving dangerous substances, *Official Journal of the European Union*, L (197), 24.7.2012.
- Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks, *Official Journal of the European Union,* L (288), 6.11.2007.
- Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage, *Official Journal of the European Union*, L (143), 30.4.2004.
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, *Official Journal of the European Communities*, L (327), 22.12.2000.
- DIVA Model, http://www.diva-model.net/.
- DROUGHT-R&SPI Project, http://www.eu-drought.org/.
- Ecorys, "Study on the EU Space Programme 2014-2020", *Draft Final Report*, 18.4.2010, contract n. SI2.541751.
- EMPERIE Project, www.emperie.eu.
- Eurocodes, EN 1998 Eurocode 8: Design of structures for earthquake resistance, http://eurocodes.jrc.ec.europa.eu/showpage.php?id=138.

- European Aviation Safety Agency (EASA), *Annual Safety Review,* 2012, http://www.easa.europa.eu/communications/general-publications.php.
- European Centre for Disease Prevention and Control (ECDC), http://ecdc.europa.eu.
- European Centre for Disease Prevention and Control, "Antimicrobial resistance surveillance in Europe", *Surveillance Report*, 2012, 1, available at: http://ecdc.europa.eu/en/publications/Publications/antimicrobial-resistance-surveillance-europe-2012.pdf.
- European Commission, *Communication of the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on a new EU Forest Strategy: for forests and the forest-based sector,* COM(2013) 659 final, 20.9.2013.
- European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Maximising the Development Impact of Migration*, COM(2013) 292 final, Brussels, 21.5.2013.
- European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions on Green Infrastructure (GI) — Enhancing Europe's Natural Capital*, COM (2013) 249 final, Brussels, 6.5.2013.
- European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions on an EU Strategy on adaptation to climate change*, COM(2013) 216 final, Brussels, 16.4.2013.
- European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on a Blueprint to Safeguard Europe's Water Resources,* COM(2012) 673 final, Brussels, 14.11.2012.
- European Commission, *Communication from the Commission to the Council and the European Parliament on the comprehensive risk and safety assessments ("stress tests") of nuclear power plants in the European Union and related activities*, COM(2012) 571 final, Brussels, 4.10.2012.
- European Commission, *Communication from the Commission to the Council and the European Parliament on the interim report on the comprehensive risk and safety assessments ("stress tests") of nuclear power plants in the European Union,* COM(2011) 784 final, Brussels, 24.11.2011.
- European Commission, *Communication from the Commission to the European Parliament and the Council on an Action Plan against the rising threats from Antimicrobial Resistance*, COM(2011) 748 final, Brussels, 15.11.2011.
- European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Our life insurance, our natural capital: an EU biodiversity strategy to 2020,* COM(2011) 244 final , Brussels, 3.5.2011.
- European Commission, *Communication on Critical Information Infrastructure Protection Achievements and next steps: towards global cyber-security*, COM(2011) 163 final, Brussels, 31.3.2011.
- European Commission, *Communication from the Commission to the European Parliament and the Council on The EU Internal Security Strategy in Action: Five steps towards a more secure Europe*, COM(2010) 673 final, Brussels, 22.11.2010.
- European Commission, *Communication from the Commission to the Council and the European Parliament on a Draft Roadmap towards a Common Information Sharing*

Environment (CISE) for the surveillance of the EU maritime domain, COM(2010) 584 final, Brussels, 20.10.2010.
- European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Towards the integration of maritime surveillance: A common information sharing environment for the EU maritime domain*, COM(2009) 538 final, Brussels, 15.10.2009.
- European Commission, *Communication from the Commission to the European Parliament and the Council on Strengthening Chemical, Biological, Radiological and Nuclear Security in the European Union – an EU CBRN Action Plan*, COM(2009) 273 final, Brussels, 24.6.2009.
- European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Critical Information Infrastructure Protection Protecting Europe from large scale cyber-attacks and disruptions: enhancing preparedness, security and resilience*, COM(2009) 149 final, Brussels, 30.3.2009.
- European Commission, *Communication from the Commission to the European Parliament and the Council addressing the challenge of water scarcity and droughts in the European Union,* COM(2007) 414 final, Brussels, 18.7.2007.
- European Commission, *Communication from the Commission on a European Programme for Critical Infrastructure Protection (EPCIP)*, COM(2006) 786 final, Brussels, 12.12.2006.
- European Commission, *Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on a strategy for a Secure Information Society – Dialogue, partnership and empowerment*, COM(2006) 251, Brussels, 31.5.2006.
- European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Network and Information Security: Proposal for a European Policy Approach*, COM(2001) 298 final, Brussels, 6.6.2001.
- European Commission, *Commission Green Paper On Forest Protection and Information in the EU: Preparing forests for climate change*, COM(2010) 66 final, Brussels, 1.3.2010.
- European Commission, *Commission Staff Working Document on a new approach to the European Programme for Critical Infrastructure Protection Making European Critical Infrastructures more secure*, SWD(2013) 318 final, Brussels, 28.8.2013.
- European Commission, *Commission Staff Working Document on Adapting infrastructure to climate change accompanying the Commission Communication An EU Strategy on adaptation to climate change COM(2013) 216 final*, SWD(2013) 137 final, Brussels, 16.4.2013.
- European Commission, *Commission Staff Working Document on Adapting to climate change impacts on human, animal and plant health accompanying the Communication An EU Strategy on adaptation to climate change COM(2013) 216 final*, SWD(2013) 136 final, Brussels, 16.4.2013.
- European Commission, *Commission Staff Working Document on Risk Assessment and Mapping Guidelines for Disaster Management*, SEC(2010) 1626 final, Brussels, 21.12.2010.
- European Commission, *Commission White Paper on Adapting to climate change: Towards a European framework for action*, COM(2009) 147/4, Brussels, 2009.
- European Commission and High Representative of the European Union for Foreign Affairs and Security Policy, *Joint Communication on Cybersecurity Strategy of the*

European Union: An Open, Safe and Secure Cyberspace, JOIN(2013) 1 final, Brussels, 7.2.2013.
- European Commission, High Representative of the European Union for Foreign Affairs and Security Policy, *Joint proposal for a Council Decision on the arrangements for the implementation by the Union of the Solidarity clause*, JOIN(2012) 039 final, 21.12.2012.
- European Commission, Directorate General for Enterprise and Industry (DG ENTR), available at: http://ec.europa.eu/enterprise/security.
- European Commission, Directorate General for Health and Consumers (DG SANCO), available at: http://ec.europa.eu/health/climate_change/policy/index_en.htm.
- European Commission, Directorate General for Home Affairs (DG HOME), available at: http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/crisis-and-terrorism/critical-infrastructure/index_en.htm.
- European Commission, Directorate General for Humanitarian Aid and Civil protection (DG ECHO), available at: http://ec.europa.eu/echo/funding/financial_instrument_en.htm.
- European Commission, Directorate General for Research and Innovation (DG RTD), available at: http://ec.europa.eu/research/index.cfm?pg=dg.
- European Commission, *Progress Report on the Implementation of the EU CBRN Action Plan*, May 2012. European Commission, *Proposal for a Directive of the European Parliament and of the Council establishing a framework for maritime spatial planning and integrated coastal management*, COM(2013) 133 final, Brussels, 12.3.2013.
- European Environment Agency (EEA), "Climate change, impacts and vulnerability in Europe", *Technical Report No. 12/2012*, 2012, 201-206, available at: http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012.
- European Flood Awareness System (EFAS), http://www.efas.eu/.
- European Forest Fire Information System (EFFIS), http://forest.jrc.ec.europa.eu/effis/.
- European Nuclear Safety Regulators Group, *Peer review report: Stress tests performed on European nuclear power plants*, 2012, available at: http://www.ensreg.eu/sites/default/files/EU%20Stress%20Test%20Peer%20Review%20Final%20Report_0.pdf.
- European Parliament, Committee on the Environment, Public Health and Food Safety, *Report on 'Towards a stronger European disaster response: the role of civil protection and humanitarian assistance',* A7-0283/2011, 19.7.2011.
- Europol, *TE-SAT 2013: EU Terrorism Situation and Trend Report*, 2013, available at: https://www.europol.europa.eu/sites/default/files/publications/europol_te-sat2013_lr_0.pdf.
- EU Agency for Network and Information Security (ENISA), http://www.enisa.europa.eu/.
- EU Seventh Framework Programme for Research and Technological Development (2007-2013), http://ec.europa.eu/research/fp7/index_en.cfm.
- EU Sixth Framework Programme for Research and Technological Development (2002-2006), http://ec.europa.eu/research/fp6/index_en.cfm.
- EU Transport in Figures, Statistical pocketbook, 2013, http://bookshop.europa.eu/en/eu-transport-in-figures-pbMIAA13001/.
- EWENT project, http://ewent.vtt.fi/.
- FLOODsite Project, http://www.floodsite.net/.
- Forzieri G., et al., "Ensemble projections of future streamflow droughts in Europe", *Hydrology and Earth System Sciences*, 18:1, 2014, 85-108.
- FUME Project, http://www.meteo.unican.es/en/projects/fume.

- Gardiner B., *et al.,* "Destructive Storms in European Forests: Past and Forthcoming Impacts", Commission (DG ENV) report, *European Forest Institute*, 2010, 4, available at: http://ec.europa.eu/environment/forests/pdf/STORMS%20Final_Report.pdf.
- GEM Project, http://www.globalquakemodel.org/.
- Hinkel J., et al., "The vulnerability of European coastal areas to sea level rise and storm surge", Contribution to EEA*, The European Environment – state and Outlook 2010 (SOER)*, 2010, available at: http://www.eea.europa.eu/soer.
- Hinkel J., et al., "Assessing risk of and adaptation to sea-level rise in the European Union: an application of DIVA". *Mitigation and Adaptation Strategies for Global Change*, 15, 2010, 703–719.
- Horizon 2020, EU Framework Programme for Research and Innovation (2014-2020), http://ec.europa.eu/programmes/horizon2020/en.
- Innovative Medicines Initiative (IMI), http://www.imi.europa.eu/.
- IMPRINTS Project, http://www.imprints-fp7.eu/en/projectes.
- International Atomic Energy Agency, *IAEA Safety Glossary*, 2007, available at: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1290_web.pdf.
- International Nuclear Event Scale of the IAEA, available at: http://www.iaea.org/Publications/Factsheets/English/ines.pdf.
- Intergovernmental Panel on Climate Change, "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)", *Special Report,* 2012, available at: http://ipcc-wg2.gov/SREX/.
- Joint Programming Initiative on Antimicrobial Resistance (JPIAMR), http://www.jpiamr.eu/.
- Joint Research Centre, "Overview of Disaster Risks that the EU faces", *JRC Technical Report*, 2013, available at: http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/29598/1/lb-na-25822-en-n.pdf.
- Krausmann E., et al., *Space Weather and Power Grids: Findings and Outlook*, Publications Office of the European Union, 2013.
- Krausmann E., Baranzini D., "Natech risk reduction in the European Union", *Journal of Risk Research*, 15:8, 2012.
- Marzocchi W., et.al., Principles of multi-risk assessment, Interaction amongst natural and man-induced risks, *European Commission Project Report*, 2009, available at: http://ec.europa.eu/research/environment/pdf/multi-risk_assessment.pdf.
- MATRIX project, http://matrix.gpi.kit.edu.
- MICORE Project, http://www.micore.eu/.
- MOTIVE Project, http://www.motive-project.net/.
- MOWE – IT project, http://www.mowe-it.eu.
- Munich RE, "Floods dominate natural catastrophe statistics in first half of 2013", *Press Release,* 9.7.2013, available at: http://www.munichre.com/en/media_relations/press_releases/2013/2013_07_09_press_release.aspx.
- Neoshield Project, http://www.neoshield.net/en/index.htm.
- NERA Project, http://www.nera-eu.org/.
- Organisation for Economic Co-operation and Development (OECD), "Future Global Shocks. Improving Risk Governance", *OECD Reviews of Risk Management Policies*, 2011, available at: http://www.oecd.org/governance/48329024.pdf.
- PEARL Project, http://www.pearl-fp7.eu.
- PESETA II Project, http://peseta.jrc.ec.europa.eu/methodology.html.
- PREDEMICS Project, http://predemics.biomedtrain.eu.

- Rapid NaTech Risk Assessment Tool (RAPID-N), http://rapidn.jrc.ec.europa.eu/.
- REAKT Project, http://www.reaktproject.eu/.
- Regulation (EU) 1305/2013 of the European Parliament and the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005, *Official Journal of the European Union*, L (347), 20.12.2013.
- RESPONSES Project, http://www.responseproject.eu/.
- RISC-KIT Project, http://www.risckit.eu.
- RISES-AM project, http://risesam.eu/.
- Rojas R., Feyen L., Watkiss P., "Climate change and river floods in the European Union: Socio-economic consequences and the costs and benefits of adaptation", *Global Environmental Change*, 23:6, 2013, 1737-1751.
- Russo S., et al., "Projection of Occurrence of extreme dry-wet years and seasons in Europe with stationary and non-stationary Standardized Precipitation Index", *Journal Geophysical Research: Atmospheres*, 118, 2013, 1-12.
- San-Miguel-Ayanz J., Camia, A., "Forest Fires", in EEA, "Mapping the impacts of the natural hazards", *Technical report no. 13*, 2010, http://www.eea.europa.eu/publications/mapping-the-impacts-of-natural.
- SHARE Project, http://www.share-eu.org/.
- Solar and Heliospheric Observatory (SOHO), NASA, http://sohowww.nascom.nasa.gov/spaceweather/. STARFLOOD Project, http://www.starflood.eu/.
- STREST Project, http://www.strest-eu.org.
- Syner-G Project, http://www.vce.at/SYNER-G/.
- Transatlantic Taskforce on Antimicrobial Resistance, "Recommendations for future collaboration between the US and EU", *Tatfar Report*, 2011, available at: http://ecdc.europa.eu/en/activities/diseaseprogrammes/tatfar/documents/210911_tatfar_report.pdf.
- Treaty on the Functioning of the European Union, *Official Journal of the European Union*, C (115), 9.5.2008.
- United Nations Framework Convention on Climate Change (UNFCCC), *Report of the Conference of the Parties on its eighteenth session, held in Doha from 26 November to 8 December 2012*, 28.02.2013, available at: http://unfccc.int/resource/docs/2012/cop18/eng/08a01.pdf.
- WEATHER project, www.weather-project.eu.
- World Economic Forum, *Insight Report: Global risks 2014. Ninth Edition,* 2014, available at: http://www3.weforum.org/docs/WEF_GlobalRisks_Report_2014.pdf.
- World Economic Forum, *Insight Report: Global risks 2012, Seventh Edition*, 2012, available at: http://reports.weforum.org/global-risks-2012/.
- World Health Organisation, "Summary of probable SARS cases with onset of illness from 1 November2002 to 31 July 2003", *Global Alert and Response (GAR)*, 31.12.2003, available at: http://www.who.int/csr/sars/country/table2004_04_21/en/.
- World Organisation for Animal Health, http://www.oie.int/en/.