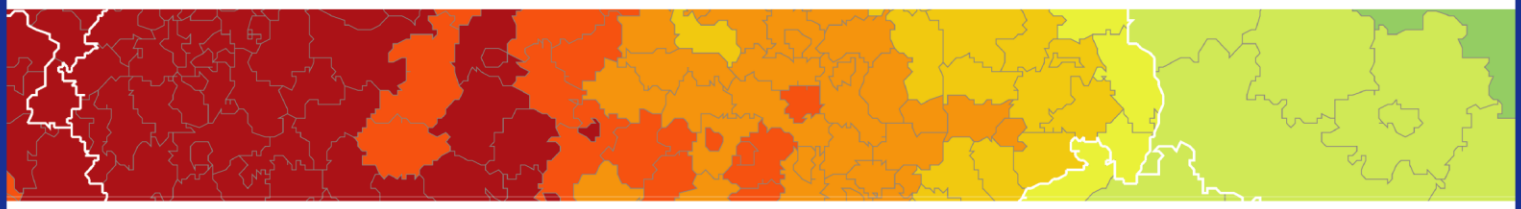
ESPON

EUROPEAN UNION

Co-financed by the European Regional Development Fund



ESPON-TITAN
Territorial Impacts of Natural Disasters

Applied research

Final Report – Annex 4
Policy Instruments Analysis

June 2021

This applied research activity is conducted within the framework of the ESPON 2020 Cooperation Programme.

The ESPON EGTC is the Single Beneficiary of the ESP7ON 2020 Cooperation Programme. The Single Operation within the programme is implemented by the ESPON EGTC and co-financed by the European Regional Development Fund, the EU Member States, the United Kingdom and the Partner States, Iceland, Liechtenstein, Norway and Switzerland.

This delivery does not necessarily reflect the opinion of the members of the ESPON 2020 Monitoring Committee.

Authors
Mark Fleischhauer, Stefan Greiving, Polina Mihal, Pauline Fehrmann, Maren Blecking, Lena Jorg, TU Dortmund University (Germany)

Advisory Group
Project Support Team: Adriana May, Lombardy Region (Italy), Marcia Van Der Vlugt, Ministry of the Interior and Kingdom Relations, Spatial Development Directorate (the Netherlands)

ESPON EGTC: Zintis Hermansons (Project Expert), Caroline Clause (Financial Expert)

Information on ESPON and its projects can be found on www.espon.eu.

The web site provides the possibility to download and examine the most recent documents produced by finalised and ongoing ESPON projects.

Contact: info@espon.eu

ISBN: 978-2-919816-06-4

ESPON-TITAN
Territorial Impacts
of Natural Disasters

Table of contents

List of Figures

List of Tables

Abbreviations

CCA	Climate Change Adaptation
CoR	European Committee of the Regions
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EC	European Commission
ECI	European Critical Infrastructure
EEA	European Environment Agency
EIA	Environmental Impact Analysis
EM-DAT	Emergency Events Database provided by Centre for Research on the Epidemiology of Disasters
ESPON	European Territorial Observatory Network
EU	European Union
EUSALP	European Strategy for the Alpine Region
FRMD	Flood Risk Management Directive
GIS	Geographic information system
IPCC	Intergrovernmental Panel on Climate Change
JRC	Joint Research Center
NRA	National Risk Assessment
PLANALP	Platform on Natural Hazards of the Alpine Convention
SEA	Strategic Environmental Assessment
SREX	Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change by IPCC
UCPM	Urban Civil Protection Mechanism
UN	United Nations
UNISDR	United Nations International Strategy for Disaster Reduction
WFD	Water Framework Directive

1 Introduction

1.1 Scope and approach of the analysis

The findings compiled in this Scientific Report are based on a multi-methodological approach and collected mainly from the overview of DRM practice performed ESPON-TITAN, as well as from its analysis of Case studies, where the following items were considered:

Overview of DRM practice in Europe:

- Description of the **practice of DRM and CCA** with a focus on prevention through risk assessment and consequent spatial planning measures as well as innovative approaches such as residual risk management through disaster management plans and procedures.
- Identifcation of **good practices of disaster risk and climate change assessment and management;**
- Collection of **innovative governance structures for DRM and CCA, especially including spatial planning**;
- Analysis on EU-level situation: The **role of EU directives and their potential to support good and effective practice of DRM**.

ESPON-TITAN analysis of case studies:

- Identification and description of successful cooperation mechanisms;
- Interviews with key actors to identify qualitative contexts of DRM and CCA and to estimate the effectiveness of policies and instruments;
- Identification of good practices of disaster risk and climate change assessment and management.

The very detailed aspects of risk mitigation through structural works and adaptation of buildings and infrastructure to make them more resistant to the disaster effects, were only partially touched in the case studies.

1.2 Criteria to describe good and effective practice of DRM

Several UN and EU documents (EU, 2007; EC, 2009; EC, 2010; EU, 2011; EC, 2013; EC, 2014; UNISDR, 2015; Poljanšek et al., 2017; ECA, 2018; Poljanšek, et al. 2019) describe criteria that should be met in order to perform a sound and **effective DRM** – be it at the national, regional or local level. These criteria can serve as a general assessment scheme but at the same time as selection criteria to define **innovative policies and instruments** and **effective practices**. According to the documents analysed, the following criteria seem to be most important:

Risk assessment: help policymakers to develop an evidence base for DRR frameworks at different territorial scales:

- Provide data: the provision of comparable, standardised and up to date data is a cornerstone for any risk assessment.
- Collaborative approach across sectors: involve experts from different research communities (natural hazards, socio-economic, policy-oriented) and take care of harmonised assessment approaches.
- Vulnerability data: take into account socio-economic data (especially elements that need to be protected) in order to assess risk and diversify management options.
- Multi-hazard risk assessment: consider, overlay and integrate relevant hazards and risks within a territory.
- Tools for prioritizing and for risk mapping: Provide for and support stakeholders in selecting relevant hazards and producing robust risk maps.
- Consideration of critical infrastructures: these are especially vulnerable but can at the same time amplify risks within the system.
- Consideration of cascading effects: assessment should be based on the interrelation between sectors and activities the identification of cascading or domino effects.
- Parallel modelling approach: Consider time and dynamics of hazards and vulnerabilities in the assessment concept.
- Scenarios of future development: working with scenarios helps to think of possible futures, even in settings of uncertainty but at the same time to consider future changes (due to demography, economic structural change or climate change) as well as potential extreme events (unlikely events, failures of protection measures etc.).
- Provide quantitative results to allow comparability across sectors, territories and time.
- Provide results in maps: show the levels and natures of risk, different for each return period (or annual probability or likelihood) and hazard type (e.g., a GIS map of the potential impacts) in order to show the spatial extent of risk.
- Regular update of assessments.
- Coordination of all involved stakeholders.

General:

- Stakeholder involvement: increases the quality and acceptance of risk assessment and risk management (involvement already in the development and selection of methodologies).
- Integration of climate change in DRM and closer cooperation between DRM and CCA action and concepts.
- Cross-border assessment and management initiatives.

Role of spatial planning in risk management and CCA: (some criteria are specifically relevant for assessing the role of statial planning in DRM and CCA)

- Integration of DRM and CCA in planning laws.
- Primary integration of risk assessment and management into spatial planning processes: hazards and risks that are already integrated in spatial plans call for a more effective DRM than a secondary integration of sectoral hazard and risk maps.
- Territorial approach: identify management options that mitigate risks in the whole territory instead of following unconnected sectoral approaches.
- Planning instruments, incl. EIA.
- Hazard zoning as a basis for planning decisions.
- Specific sectoral management plans and instruments.
- Innovative strategies (no regret strategies; retreat; burden sharing).

1.3 Relevance of hazards in ESPON countries

In the ESPON-TITAN project, river floods, storms, earthquakes and droughts are chosen as the main natural hazards to be analysed. Others, such as flash floods, tsunamis or landslidesare considered selectively. Of course, not all of these hazards are relevant for every ESPON country. In order to show the relevance of hazards in the ESPON countries and to narrow the following working steps only to the relevant hazards, the hazard profiles were identified based on three sources: the EM-DAT database (EM-DAT, 2020), the list of the main disaster risks assessed for the EU Urban Civil Protection Mechanism (UCPM) participating countries (EC, 2017: 12ff.) as well as the preliminary assessment results within the ESPON-TITAN project (see ESPON-TITAN final report). Table 1.1 integrates the information from these three sources.

It is interesting to see that all three sources generally match (especially with flood risk) but divert from each other in some details. Storms, e.g., have caused large damages in Europe thoughout the past but are considered in the National Risk Assessments (NRA) by only a minority of countries. On the other hand droughts have caused only little damage – accoding to past events – but seem to highly perceived in the countries' NRAs – a fact that can be interpreted as taking care of the precautionary principle against the background of changing climate. Apart from these observations the overview supported the selection of the most relevant hazard/country combination for our analysis.

Table 1.1 Relevance and selection of natural hazards under ESPON-TITAN framework

Country	Drought	Earthquake + Tsunami	Tsunami	Flood + Riverine flood	Flood - Coastal flood	Flood - Flash flood	Storm + trop./extra-trop.	Storm convective	Landslide - Mudslide	Avalanche
Austria				4		1	4	3	1	3
Belgium		3		4		1	4	3		
Bulgaria		2		3			4			
Croatia	1	1		3		1		1		
Cyprus		3					3	3		
Czech Republic				4		3	3	2		
Denmark	1						3	1		
Estonia							3			
Finland				1			1			
France	1		2	4		4	4	4		3
Germany		4		4		1	4	4		2
Greece	1	4		3			3			
Hungary		1		4			4	2		
Iceland		3		1					1	3
Ireland				4		3	4	1		
Italy	1	4		4		4	3	4	3	2
Latvia							3			
Lithuania	1					1	3			
Luxembourg				1			2			
Malta										
Netherlands		1		3		3	4	2		
Norway				4			2	2		
Poland		1		4		4	4	3		
Portugal	1			4		3	3	3		
Romania	1	4		3		2	2	2	1	
Slovakia				4		3	3			1
Slovenia		4		3			3			
Spain	2	4		4		3	3	2	3	
Sweden				2			3	1		
Switzerland				4			4	4	4	4
Turkey										
United Kingdom		3		4	2	3	4	4	1	

4/3/2/1	=	EM-DAT data base: Damage data recorded for 1960-2010 in all 4, 3, 2 or 1 category of the data base (Total deaths; Total affected; Total damage ('000 US$); Insured losses ('000 US$))
	=	High / very high hazard category (depending on specific hazard) according to interim results of ESPON-TITAN
	=	Medium / high hazard category (depending on specific hazard) according to interim results of ESPON-TITAN
	=	Country / hazard combination assessed per UCPM participating country (EC, 2017:12 ff.)
	=	Country / hazard combination not to be considered in Task 6 analysis

Source: ESPON-TITAN (2020), based on EM-DAT, 2020; EC, 2017

2 Instruments on Disaster Risk Management and Climate Change Adaptation

The presented findings are based on a multi-methodological approach. A desktop analysis, which focussed on existing studies on DRM and CCA practices in Europe was combined with primary data from the case study analyses (document analyses and expert interviews). Results focus on the state-of-the-art in risk assessment and climate impact assessments as an evidence basis for management actions. Risk management and climate adaptation practices encompass spatial planning measures as well as innovative approaches, such as residual risk management through disaster management plans and procedures. Some good practices collected on the inclusion of innovative governance structures for DRM and CCA into spatial planning may illustrate some of the conclusions presented. As it will be seen, the crucial role of EU directives and their potential to support good and effective practice of DRM is considered.

The deepening of the analysis through case studies allowed the identification and description of successful cooperation mechanisms, qualitative contexts of DRM and CCA, and an estimation of effectiveness of policies and instruments, which are always context-dependent due to the heterogenity of legal-administrative systems and cultural settings throughout Europe. Some good practices were acknowledged from the interviews with local stakeholders. However, detailed aspects of risk mitigation through structural works and adaptation of buildings and infrastructure, to make them more resistant to the disaster effects, were only touched partially in the case studies.

2.1 Practice of DRM and CCA

The main objective envisaged in this working step was the identification of instruments and tools (predominantly in spatial planning/territorial development) for DRM and CCA measures as well as the assessment of their benefits and usefulness. This Annex Report shows literature and an analysis of DRM and CCA practices in the ESPON countries for river flood, windstorm, earthquake, drought, and other selected hazards, structured along with the criteria of risk assessment, risk management, climate change assessment and CCA as well as good practice examples. Derived from this collection and supported by the results from existing metastudies the following – non-exhaustive – findings regarding the practice of DRM and CCA in Europe were made.

2.1.1 Risk assessment

According to an earlier communication of the EC, it was already confirmed in research projects and publications that risk mapping is complex and gaps remain in the methodologies. Although hazard mapping was considered to be improved (especially because of the wider use of GIS techniques), the creation of risk maps by including social, economic and environmental variables still was a challenge (EC, 2010: 35 fIn the meantime, however, in recent years the NRAs that were submitted to the Commission have shown that the huge progress has been made as Poljanšek et al. (2021) summarise in the JRC report on recommendations for national

risk assessment for disaster risk management. Based on the review of National Risk Assessment (NRAs) they conclude that in these assessments the spectrum of hazards and threats addressed has been continuously enlarged, that climate change is included and interactions among hazards are considered, that a long-term prevention-oriented planning perspective complements the short-term reactive perspective and a stronger involvement of research institutions in risk assessment (Poljanšek et al., 2021: 22). However, these improvements do not seem to completely overcome the deficits that were identiefied in the report from 2019, such as the low coverage of the dynamic nature of risk, the change of risk factors, and how the assessments support DRM planning and finally action. Also the recommendation to enhance quantitative approaches in order to replicate and compare results at EU level still is a pending issue (Poljanšek et al., 2019: 13).

Table 2.1 Types of integrating spatial hazard information into the spatial planning process

Type	**Coordinated zoning in general land-use plan**	**Specific hazard map in general land-use plan with binding effects**	**Independent map without binding effects**
Description	Consideration of the hazard-prone areas during the compiling or review of the local land-use plan (informed, e.g. by Strategic Environmental Assessment; examples: Finland, Poland, Germany with the exception of river floods).	The hazard zones are displayed as a separate map which (partly) are mandatory to be considered in land-use planning (examples: Austria, France, Italy, Switzerland, Germany in the case of river floods).	Definition of hazard zones within the scope of expert planning – objections may be raised to decisions that are made on this basis. Independent hazard maps or hazard zone plans without obligation to include them in land-use plans (examples: Germany in the case of alpine hazards, France, Greece, UK).
Advantages	Risk communication is integrated into the public consultation process. At the local level, no additional instruments are needed; hazards are weighed-up against other concerns and interests.	Hazards are treated according to uniform principles in all municipalities. Definition of hazard zones can be applied directly in building approval procedures. No “weighing away” possible.	Changes to hazard zone and land-use plans can easily be made. Particularly suitable for discursive strategies that also reach private individuals with their building provision.
Disadvantages	Land-use plans only contain information about hazard prone areas when a specific reference is made. An alternation of the danger situation means the plan must be adapted accordingly. Consideration of risks depends on the ability of planners to assess risks properly. In addition, the danger of political influences (deliberate fading out of risks).	Binding effects require a very precise evidence base (climate change). -Often acceptance problems. Presupposes compliance with the law. An alteration of the risk means that the complete zoning plan has to be adapted accordingly.	No effect in case of lack of knowledge or acceptance.

Source: ESPON-TITAN (2020), based on Van Westen and Greiving (2017: 88)

As ESPON has an explicit territorial approach it is important to take a territorial or spatial perspective on risks. Considering the spatial risk context means to go beyond sectoral risk assessment approaches and consider the entirety of risks that exist in an area, calling for multi-risk assessment and management. An assessment of recent research activities, however, shows that so far multi-risk perspectives are not systematically addressed among disaster risk management approaches in EU countries and that single-hazard maps are still the most often used decision support tool. The authors further conclude that barriers to implement multi-risk assessment into DRM are found in science and practice, resulting in a general lack of integrated

practices for multi-risk governance (Poljanšek et al., 2017: 113). Even the good practice examples that aim at a multi-hazard perspective in risk assessment (e.g. Austria, France, Italy, Switzerland) rather overlay layers of various hazards that really integrate hazards by assessing (modelling) interdependencies and effects due to the accumulation of hazards (see also case study reports for a detailed description).

A decisive point regarding the effectiveness of DRM is how information on natural hazards (i.e. the results of hazard assessment) is used to inform decision making and especially how spatial information about hazards is integrated into the spatial planning process. In principle, there are three types of primary integration, secondary integration and informative support (Table 2.1).

A comparative overview of the characteristics of national risk assessments as well as the criteria to describe probability/likelihood and impact/consequences of disasters is provided in the Commission Staff Working Document "Overview of natural and man-made disaster risks the European Union may face" (EC, 2017: 68).

2.1.2 Risk management

Risk management approaches vary considerably among the European countries, too. In their comparative analysis for the Committee of Regions on the implementation of the Sendai Framework at the EU level the authors come to the conclusion that there is a "wide, diversified panorama of administrative and legal systems that manage the different national civil protection mechanisms throughout the EU" (CoR, 2016a: 15). However, disaster risk management can be broadly grouped as follows (CoR, 2016a: 16):

- Decentralised management with legislative competence: Austria, Germany, Spain, Italy;
- Partially decentralised management: Belgium, Bulgaria, Czechia, Denmark, Greece, Finland, France, Croatia, Ireland, Latvia, Netherlands, Poland, Portugal, Romania, Slovenia, Sweden, Slovakia, UK;
- Primarily centralised management: Cyprus, Estonia, Hungary, Luxembourg, Lithuania, Malta.

In many European countries DRM still is ineffective because coordination and cooperation mechanisms are still weakly developed. This led Poljanšek et al. (2019) to the recommendation that a robust and flexible governance model in which one authority has the mandate to coordinate all parties involved is essential. Further, any kind of risk management or governance shall enhance coherence across sectors and create a working environment based on the same set of evidences. For example, risk should be assessed in collaboration with stakeholders, including those on central and regional levels of government and specialised departments (Poljanšek et al., 2019: 16). In order to improve the countries' resilience against disaster risk, Poljanšek et al. (2021) recommend in the latest report on NRA for DRM in the European Union to prioritise the development of national risk assessment capability and to base this on regular risk management capability assessments (RMCA). RMCAs can support a sustainable development of capabilities for the implementation of an integrated DRM, as well as a continuous adaptation to changes of risk profiles (e.g. due to climate change or new and emergent risks).

2.1.3 The example of flood risk

ESPON-TITAN has chosen flood, drought, storm and earthquake risks to be analysed throughout the ESPON space. However, only for flood risk management, an EU directive (with the requirement to implement it in national legislations) exists. Thus, flood risk is the hazard that is most advanced in terms of a European-wide harmonised risk assessment and management due to the coming into force and implementation of the Flood Risk Management Directive since 2007. Therefore, the example of flood risk can ideally serve to compare advantages and challenges of disaster risk assessment and management from a European perspective. In their report on the implementation of the FRMD, the authors identified overall positive effects, especially improvement of coordination between the Commission and the Member States, progress in the assessment of flood risks, consideration of previous work, including existing long-standing cooperation between the Member States as well as activities to raise flood awareness among citizens in Member states (ECA, 2018: 44).

On the other hand, the team of auditors (ECA, 2018) found still existing weaknesses: weaknesses in allocating funding, insufficient funds for planned flood-related action, and limited funding for cross-border investments, generally not quantified or time-bound objectives (especially commonly agreed protection goals) in the flood risk management plans, weak linkage of project ranking procedures to the priorities in the FRMPs. They thus recommend improvements in data provision, cost-benefit analyses and models to design projects, better coordination of the implementation of the FRMD and WFD and supporting the implementation of green infrastructure projects as they have multiple benefits (ECA, 2018: 2).

As major challenges for the future the auditors identified the lack of up-to-date knowledge on the likely impact of climate change on the incidence of floods, the practice of using statistical data from historical events for determining frequency-magnitude relationships, which carries the risk of not reflecting climate change, where applicable, private flood insurance coverage is still low and regarding land use and spatial planning regulations to mitigate flood risk they conclude that Member States still had more to do (ECA, 2018: 2).

2.1.4 Integration of climate change and other issues in disaster risk management

Although climate change impacts are not analysed in ESPON-TITAN, it is nevertheless of interest to have a closer look at potential synergies between DRM and CCA. Although CCA mainly addresses long-term and creeping changes and DRM in contrast addresses rapid onset events, there is a large overlap, especially in the field of strategies, measures and instruments. Already the Hyogo Framework for Action noted the interconnection between both spheres, and the Sendai Framework for Disaster Risk Reduction 2015-2030 indicated a number of considerations and priorities for action and activities related to this common agenda (EEA, 2015: 12). In addition, the SREX report of the IPCC underlined the impact of climate change on extreme events (IPCC, 2012).

The analysis in ESPON-TITAN has shown that a real integration of climate change into DRM happens in some examples but is far from being a common procedure. The analysis seems to give the impression that policy makers rather intend to integrate climate change mitigation and adaptation than climate change adaptation and disaster risk management.

A reason for this weak integration may also be the fact that below the national level, CCA strategies are not commonly adopted. Up to 2016, 29 EU Member States had either adopted or were in the process of developing National Adaptation Strategies, according to a report for the Committee of Regions (CoR). In contrast to this almost full coverage at national level, the situation looked different regarding regional adaptation strategies: “Eastern European countries, in particular, have made little progress with the development of regional strategies. In respect to Western European countries, no regional strategies are in place in some of the Member States with more centralised governments. […] With regards to the Eastern European countries that have just adopted their national strategies, or are still developing them, it is likely that further encouragement at European level can enable development at the regional level. In these countries, regional adaptation is mainly reliant on project funding” (CoR, 2016b: 63).

Moreover, there are fundamental differences between the temporal perspectives of DRM and CCA. Disaster risk assessments are always based on data from past events from which a probabilistic frequence-magnitude relationship is derived. Impacts of climate change are calculated based on a bandwidth of scenario pathways of potential future changes (Van Ruijven, 2014; Greiving et al., 2015). Finally, are neither all hazards triggered by climate change (such as earthquakes and volcanic eruptions) nor are all impacts of climate change per se risky, but promise partly positive effects (e.g. on beach tourism or agriculture in Northern Europe).

The necessity for cross-border regulations exists also because the planning sovereignty of spatial planning actors always refers to a certain area of responsibility and is therefore difficult to reconcile with the network-like character of infrastructures (Greiving et al., 2016). The protection of critical infrastructures of European, nationwide and transnational importance is therefore not a task of regional or national spatial planning or water management authorities, but requires at least a nationwide, better an EU-wide consideration and should therefore be the subject of a European regulation, which is only partly addressed by the existing EU Directive on the Protection of Critical Infrastructure of European Importance (2008/114). The paramount importance of the core network of European transport and energy infrastructure for the functioning of the EU and the internal market justifies an increased protection worthiness compared to other spatial uses, while at the same time ensuring factual and spatial certainty due to the existence of the regulation (EU) No 1315/2013 on Union guidelines for the development of the trans-European transport network and No 347/2013 on Guidelines for trans-European energy infrastructure (BMI and BBSR, 2020: 24).

Table 2.2 Consideration of climate change, cross-border risks and cascading effects in National Risk Assessments (as of 2017)

National assessment	Climate change		Cross-border risk			Cascading effects		
	Flooding	Extreme events	Flooding	Extreme events	Earth-quake	Flooding	Extreme events	Earth-quake
Austria								
Belgium	X							
Bulgaria		X	X		X		X	X
Croatia	X	X	X	X		X	X	X
Cyprus	X					X		
Czech Republic								
Denmark	X	X		X		X	X	
Estonia								
Finland		X				X	X	
France							X	X
Germany			X					
Greece						X		
Hungary	X	X	X	X		X	X	
Iceland	X	X				X	X	X
Ireland						X	X	
Italy						X		
Latvia						X		
Lithuania		X	X	X		X	X	
Luxembourg								
Malta	X	X				X	X	X
Netherlands			X			X		
Norway	X	X				X		X
Poland		X		X				
Portugal	X	X				X		
Romania	X		X		X			
Slovakia				X				
Slovenia								
Spain						X		
Sweden						X		X
United Kingdom	X	X		X		X		

Source: ESPON-TITAN (2020), based on EC, 2017a, pp.19; 23; 31.

Overall, it seems that some relevant issues for DRM, such as climate change, cross-border risks or cascading effects, have only recently grown attention. As Table 2.2 shows, they have not yet been considered in all disaster risk assessments at national levels by the year 2017. However, the situation will most likely improve with subsequent National Risk Assessments.

In their report on the coherence between DRM and CCA, the EEA recommends to develop a high-level strategic vision and local-level engagement of key actors, supported by adequate funding in order to foster this coherence. To support this hypothesis, the EEA report presents selected cases from various European countries in which effective coherence between CCA and DRR has been achieved, in various ways and to various degrees. The selection is based on criteria that define 'good practice': “coherence is deliberately planned rather than an accidental outcome; improved coherence pays off in both policy areas; and uncertainty and multiple possible futures are explicitly accounted for in risk prevention efforts, from both short- and long-term perspectives” (EEA, 2017: 13).

2.2 The role of EU directives and their potential to support DRM practice

The research on hazards, vulnerability, risk and DRM and CCA instruments developed in ESPON-TITAN is embedded in a wide set of legislative, scientific, informative and financial activities that have been initiated at EU level in order to support policies that follow resilience bulding and disaster risk reduction. Not all of these activities directly refer to DRM and CCA, although many of them have indirect effects and factual interrelations.

Recent documents and initiatives are the European Green Deal (EC 2019), which aims at a transition of EU’s economy towards a sustainable future. Climate change adaptation plays a major role in the European Green Deal and reference to disaster risk is made with regard to ecosystems that contribute to mitigating natural disasters as well as to rural and remote areas and their vulnerability to climate change and natural disasters.

The new EU Strategy on Adaptation to Climate Change (EC 2021), among others, aims at a faster adaptation process and suggests to create synergies with broader work on disaster risk prevention and reduction and to strengthen climate considerations in EU disaster risk prevention and management. Further, the financial system is seen as an important element to increase resilience to climate and environmental risks (especially risks and damage arising from natural catastrophes).

The proposed European Climate Law (EC 2020) aims at reaching the goals set in the European Green Deal and introduces requirements for national climate change adaptation strategies, which should include comprehensive risk management frameworks (Poljanšek et al., 2021).

Disaster risk reduction can be further promoted by these new policies, especially by building stronger interlinkages between CCA and DRM frameworks. However, also previous policies and the implementation of EU Directives in Member States have strongly improved spatially oriented disaster risk management and risk reduction.

2.2.1 EU directives with references to preventive risk management

In the past, important impulses for preventive and spatially oriented risk management in the EU member states came from EU legislation, as the EU-wide directives require national legislation

to be adapted. From the point of view of preventive risk management in spatial planning, especially the Flood Risk Management Directive (FRMD, 2007/60/EC), the SEVESO III Directive (2012/18/EU) and the amendment of the EIA Directive (2014/52/EU) are of importance. The ECI Directive (2008/114/EC) for the protection of European critical infrastructures also shows clear references to preventive risk management. Other directives, such as the INSPIRE Directive (Infrastructure for Spatial Information in the European Community, 2007/2/EC) do not directly or only partly show connections to preventive risk management but can potentially take care of a strong support of DRM and CCA:

- The Flood Risk Management Directive was implemented in the national laws of the member states from 2010 on. This paved the way for better coordination of flood prevention in the European, often cross-border river catchment areas. The guideline also strengthened integrated flood prevention, which focuses on managing risks rather than just protecting flood-prone areas against flood hazards (BMVI, 2017: 15).
- In view of the high potential for damage, in the event of a disaster, facilities that are inherently hazardous (hazardous installations) increasingly come into focus. With the amendment of the SEVESO Directive in 2012 (2012/18/EU), the references to land policy and land use planning were strengthened. This also addresses cascade effects caused by endangering companies, for example in the event of flood disasters.
- The amendment of the Environmental Impact Assessment Directive (2014/52/EU) makes the consideration of climate change and disaster risks a mandatory statutory task, as projects are related to carrying out an EIA. The EIA report has to include the impact of the project on climate as well as the vulnerability of the project to climate change. These aspects may have to be considered in a future amendment of the Strategic Environmental Assessment Directive (2001/42/EC) as well because also designated land-uses laid down in plans and programmes can be vulnerable to hazards and climate change.

2.2.2 Potential of EU directives to support good and effective practice of DRM

Several UN and EU documents (EU, 2007; EC, 2009; EC, 2010; EU, 2011; EC, 2013; EC, 2014; UNISDR, 2015; Poljanšek et al., 2017; ECA, 2018; Poljanšek et al., 2019; 2021) describe criteria that should be met in order to carry out a sound and **effective DRM** – be it at national, regional or local level. These criteria can serve as a general assessment scheme but at the same time as selection criteria to define **innovative policies and instruments** and **effective practices**. According to the documents analysed, a list of the most relevant criteria was collected. Table 2.3 shows these criteria and relates them to the EU directives described above in order to comment on issues already addressed by the directives and potentials for future consideration within the directives (or future amendments of these).

Table 2.3 The role of EU directives and their potential to support good and effective practice of DRM

Criteria of good and effective DRM practice	**EU Directives where addressed**	**Potential for amendment of EU Directives**
Risk assessment: help policymakers to develop an evidence base for DRR frameworks at different territorial scales		
Provide data: the provision of comparable, standardised and up to date data is a cornerstone for any risk assessment	INSPIRE	INSPIRE directive could be extended to more small-scale and standardised/ harmonised data regarding hazards and risks
Collaborative approach across sectors: involve experts from different research communities (natural hazards, socio-economic, policy-oriented) and take care of harmonised assessment approaches	FRM directive: requirement for an active involvement of interested parties regarding flood risk plans EIA directive: requirement to involve experts from different communities	
Vulnerability data: take into account socio-economic data (especially elements that need to be protected) in order to assess risk and diversify management options	FRM directive: risk maps	
Multi-hazard risk assessment: consider, overlay and integrate relevant hazards and risks within a territory	Not directly addressed by EU directives, but implicitly covered by EIA Directive	
Tools for prioritizing and for risk mapping: Provide for and support stakeholders in selecting relevant hazards and producing robust risk maps	FRM directive: hazard and risk maps	
Consideration of critical infrastructures: these are especially vulnerable but can at the same amplify risks within the system	ECI directive	ECI directive with potential to extend the protection-oriented approach to a systemic resilience approach
Consideration of cascading effects: based on the inter-relation between sectors and activities the identification of cascading or domino effects	SEVESO III directive (but only for establishments addressed by this directive)	
Parallel modelling approach: Consider time and dynamics of hazards and vulnerabilities in the assessment concept	EIA directive (amendment), requirement of assessment against baseline scenario (indirect consideration)	FRM directive: these dynamics could also be considered in hazard and risk maps
Scenarios of future development: working with scenarios helps to think of possible futures, even in settings of uncertainty but at the same time to consider future changes (e. g. due to demography, economic structural change or climate change) as well as potential extreme events (e. g. very unlikely events, failures of protection measures etc.)	EIA directive (amendment), requirement of assessment against baseline scenario	

Criteria of good and effective DRM practice	EU Directives where addressed	Potential for amendment of EU Directives
Provide quantitative results in order to allow comparability across sectors, territories and time	Not addressed by EU directives	
Provide results in maps: show the levels and natures of risk, different for each return period (or annual probability or likelihood) and hazard type (e.g., a GIS map of the potential impacts) in order to show the spatial extent of risk	FRM directive	
Regular update of assessments	FRM directive	
Coordination of all involved stakeholders	FRM directive: coordinated management plan within one catchment area/river basin	
Risk management		
Primary integration of risk assessment and management into spatial planning processes: hazards and risks that are already integrated in spatial plans call for a more effective DRM than a secondary integration of sectoral hazard and risk maps	Not addressed by EU directives	SEA directive amendment could take care of this aspect
Territorial approach: identify management options that mitigate risks in the whole territory instead of following unconnected sectoral approaches	Not addressed by EU directives	
Innovative strategies (no regret strategies; retreat; burden sharing)	Not addressed by EU directives	
Specific sectoral management plans and instruments	FRM directive: management plans	
General:		
Stakeholder involvement: increases the quality and acceptance of risk assessment and risk management (involvement already in the development and selection of methodologies)	FRM directive, involvement of interested parties	
Integration of climate change in DRM and closer cooperation between DRM and CCA action and concepts	Not addressed by EU directives	
Cross-border assessment and management initiatives	FRM directive, assessment and management according to river basins and not Member States or other administrative units	

2.3 Policy relevance of DRM and CCA instruments analysis

At the EU level as well as on the national levels of the ESPON countries several instruments exist regarding DRM and CCA. In both cases various initiatives, approaches and experiences exist and some good practice examples can be identified (see next section and also case study reports). However, the practice of DRM and CCA is still far from fulfilling the requirements for an effective spatial, risk-oriented management approach that includes also the multiple dynamics of changing hazards, exposure and vulnerability.

The research indicated that – as a main message – the challenge of improving the effectiveness of instruments can be tackled from two directions:

- Support innovations in assessment to inform decision-making and use of instruments by considering criticality and cascading effects (esp. for DRM), aiming at a parallel modelling approach (esp. for CCA) and improving the comparability of assessment methods (granularity, data, approach);
- Support the implementation of instruments by a further development of supporting instruments such as SEA directive (integration of DRM/CCA perspectives) or contingency plans that bring together different actors as well as acknowledging the high relevance of soft instruments (provide environments where experts and decision-makers learn from each other, support of trust-building measures, horizontally and vertically).

The juxtaposition of good and effective practice of DRM and the existing EU directives shows that the FRM directive occurs and thus contributes to many of these requirements. Thus, it becomes clear how much the FRM directive initiated in terms of increasing effectiveness of DRM in Europe. The question, however, is if it could be a blueprint for other directives in the area of DRM and CCA. At least in the interviews conducted in the case studies it was stated that the implementation of the WFD and FRMD helped sub-national and regional policy makers very much to find arguments to implement the issues of water protection and flood risk management.

Thus, one should not underestimate the role of directives in this respect – otherwise it is clear that an over-regulation of too many issues is politically difficult. To overcome this, the potentials that already existing directives have could be used in future amendments. Ultimately, the largest gap seems to be the provision of requirements regarding a comprehensive (multi-) risk based approach to managing territorial risks.

3 Good practice examples

3.1 Good practice of disaster risk and climate change assessment and management: assessment results and selected examples from case studies

ESPON-TITAN understands a best practice as a practice that is in line with the requirements of superordinated policies, laid out in strategic and/or formally binding documents as described before. According to the large number of political-administrative systems in the ESPON space and the variety of natural hazards that are assessed, as well as the multitude of management approaches, a formal assessment covering all countries, hazards and actions would have never been manageable. Thus, the identification of best practices followed a non-formal and practice-oriented approach.

Based on the collection of DRM and CCA practices, as well as spatial planning approaches to DRM, we identified a multitude of good practice examples (EEA, 2017: 50-66 and 116 ff.; De Groewe et al., 2014: 67 f.; Poljanšek et al., 2017: 422-430; Poljanšek et al., 2019: 154; Websites EXCIMAP, 2007; JRC Risk Data Hub, nd; GFCE-MERIDIAN, 2016). In addition to the desktop analysis in Task 6, we carried out in-depth analyses in eight case studies, consisting of a thorough analysis of policy and planning documents as well as projects and assessment and management tools and complemented these by interviews with regional and local DRM and CCA experts (see Annex 5). The case studies provided us with more illustrative good practice examples. Based on this assessment the following list of good practice examples was compiled. Some of these were further addressed in the case studies and are described further down in order to give an exemplary idea of the type and character of these good practice examples.

General DRM and CCA good practice approaches:

- Multi-hazard assessment, territorial perspective on risks (IS, MT, CH [see example below])
- Role of regional planning with coordinating function above the local level (e. g. DE [see example below], AT)
- Multi-risk and cross-sectoral management plans (CY)
- Multi-hazard zoning as a sectoral plan to inform regional and local land-use planning (AT, CH [see example below])
- Multi-hazard and extreme weather information and warning system (FI)
- System of hazard assessment and risk prevention plans for different hazards (FR)
- Cross-border involvement in hazard assessment and management (Baltic Sea Region, Dresden Region [see example below])
- Cost/benefit assessments of measures (DK, FR, NL)
- Assessment of climate change impacts on disaster risks (HR, HU)

Hazard-specific good practice approaches:

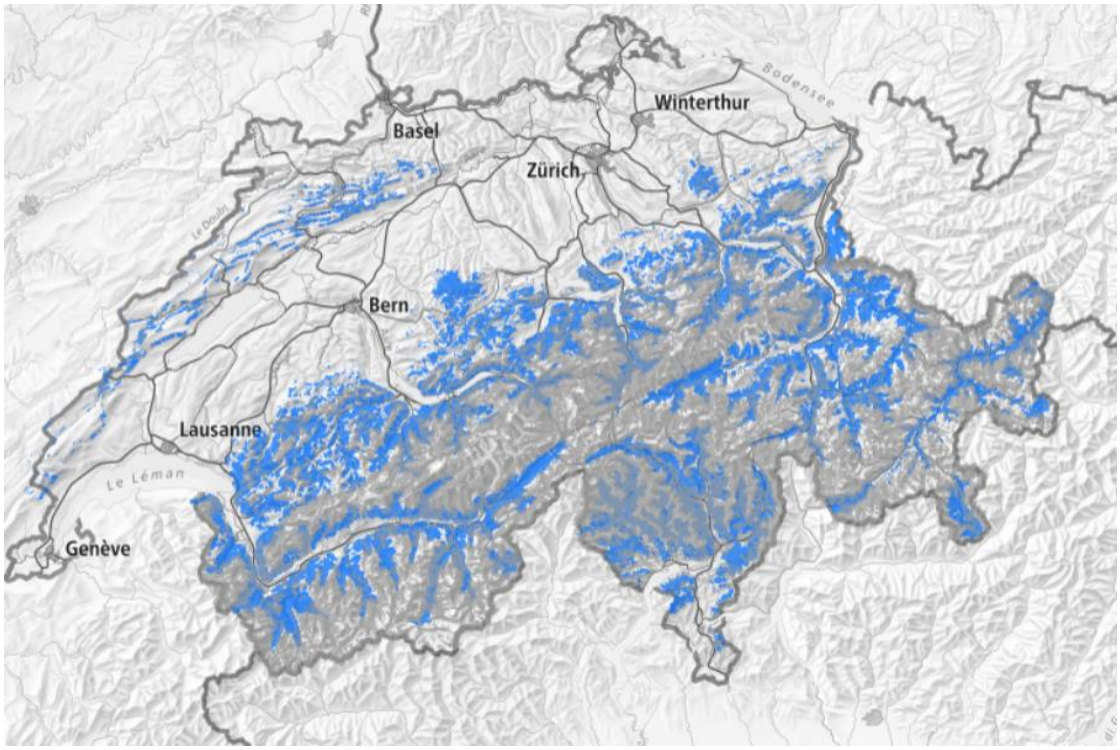
- River floods: Specific consideration of vulnerability/socio-economic data (FI, LT, NL); consideration of climate change (e.g., NL)
- Droughts: Drought prevention/management assessments and management plans (HR, CZ, IT, MT, ES)
- Storms: Storm assessments (SI, CH)
- Earthquakes: Scenario-based consideration of extreme earthquake events (Bulgaria, Italy), elaborated monitoring and management system (EL, TR)
- Others: Landslides (Italy, Norway), Tsunami (PT)

It is, however, a matter of fact, that the list of these good practices is only selective. There are definitely numerous additional good practices – especially on regional and local levels – that were not able to be identified because of limited access to documents and language barriers.

Switzerland: Multi-hazard assessment and multi-hazard zoning as a sectoral plan to inform regional and local land-use planning

Switzerland has a produced comprehensive set of hazard maps, intensity maps and hazard warning maps (BAFU, 2020). These maps are created by the Swiss cantons and can be viewed on the cantonal geoportals. In order to create a comparable and comprehensive hazard information basis for the whole country, the cantonal data is harmonised and transferred to the federal data model and finally published in the spatial data infrastructure (BAFU, 2020; see Figure 3.1).

Figure 3.1 Swiss potential areas that could be endangered by avalanches and rockfalls (BAFU, nd).



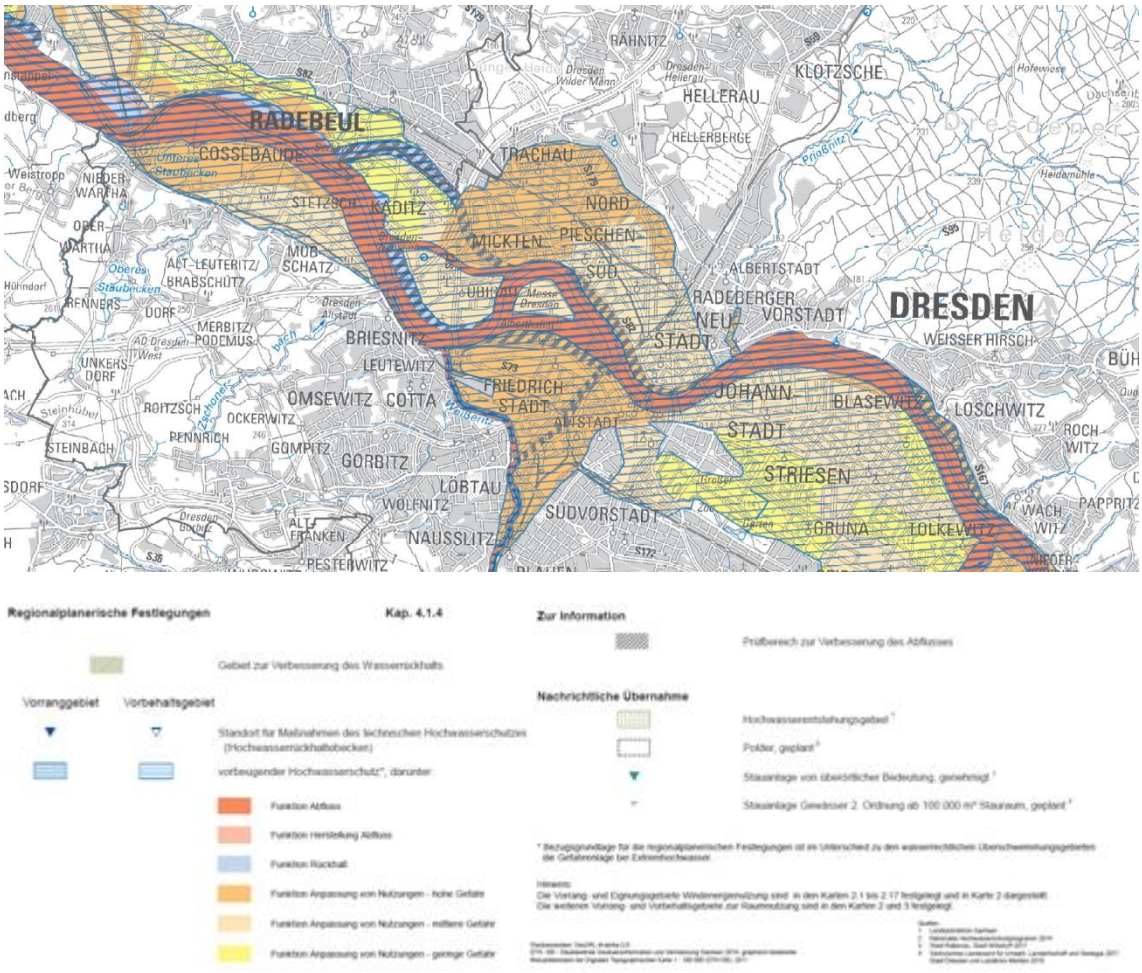
The Federal Laws on Forests and Hydraulic Engineering oblige the cantons to take the hazard maps into account for all activities with spatial relevance. In some Alpine countries like Switzerland, risk assessment, which includes risk and hazard maps, is perceived as a basis for spatial planning (Austria, Germany) (cf. Schindelegger and Kanonier, 2019: 67, 75).

Germany: Role of regional planning with coordinating function above the local level

Since 2010 the regional planning association Upper Elbe Valley/Eastern Ore Mountains dealt intensively with flood precaution regarding priority and reservation areas, because within the planning region more and more high-quality buildings should be realised on flood plain areas and therefore concerns grew that the damages would be more severe than ever before in case of a future extreme flood event (cf. RPV OEOE, 2017). On grounds of this, a novelty in terms of planning methodology for the designation of flood prevention areas was introduced by the regional planning association. They decided to not longer designate such areas based on occurrence probability but rather do it on the basis of the hazard intensity, while considering parameters like flow velocity or water depth. Further, extreme flood events will be taken for orientation instead of hundred-year floods and priority areas can be designated in the inner zone (i. e. the already existing, built-up areas) of the municipality. The juridical feasibility of such a procedure was examined and approved with the constraint to not impose blanket building bans in the inner zone. Consequently, the new methodology was implemented in the updated regional plan for the Upper Elbe Valley/Eastern Ore Mountains and inter alia it became mandatory in detailed land-use plans to build adapted to floods in priority areas. An inspection order was brought on the way for areas in municipalities where the water height during flood events will rise above four metres and the implementation will be accompanied by intensive educational work (cf. BMVBS, 2013).

In detail, this new multistage concept with regard to preventive flood protection consists of four precautionary stages: (1) natural retention of water in the catchment area, (2) technical retention by water-retaining structures, (3) water retention in flood plains and (4) the adaptation of uses in flood plains. The application of the aforementioned concept on the river Elbe, results in the fact that almost 60 percent of flood plain areas, expected in the event of an extreme flood, are designated as priority and reservation areas for the functions “runoff”, “production of runoff” and “retention”. The other flood plains are designated as reservation areas for the function “adaptation of uses - high/ medium/ low risk”. Overall, the impact of the concept is more extensive than a combination of flood and risk areas related to water law, as the largest possible extent in the respective catchment areas is subject to the designation of reservation areas for runoff and retention in settlement areas. This was evaluated as legally compliant by the licensing authority (RPV OEOE, 2020: 105ff. and Seifert, 2020). Figure 3.2 shows an excerpt from the regional plan with priority and reservation areas (hatchings), their decisive functions (colours) and their validity for settled areas in the area of the city of Dresden and its surroundings.

Figure 3.2 Preventive flood protection in the area of the city of Dresden. Excerpt from regional development plan of the planning region Upper Elbe Valley/ Eastern Ore Mountains (RPV OEOE, 2020).



Germany/Czech Republic: Cross-border involvement in hazard assessment and management

The flooding risk for the planning region Upper Elbe Valley-Eastern Ore Mountains (including the city of Dresden) is above average on the one hand due to flash floods in mountain streams in the Ore Mountains, which are tributaries to the Elbe, and on the other hand due to flooding of the Elbe river itself. The Saxon State Flood Control Centre ("Landeshochwasserzentrale") observes water levels, and critical changes are immediately reported to the counties and municipalities, who are in charge of flood prevention. For smaller rivers flood warnings for at least six to twelve hours in advance are possible, and for the Elbe river even 48 hours in advance (cf. Wasser Sachsen, nd). In order to achieve a high efficiency of early warning and protection measures, the water management units installed several cooperations with emergency response units and municipalities. An important element in this respect is the cross-border cooperation with water authorities in the Czech Republic. The city of Dresden and water management authorities signed a contract that allows local authorities in Dresden to directly get access to flood-related data from Czech water authorities upstream the river Elbe (Korndörfer, 2020).

Apart from this specific, hazard-assessment related cross-border cooperation, several cooperations between Saxon municipalities and districts that are adjacent to Poland or the Czech Republic have been established and intensified (cf. CoR, 2016a). The city of Dresden maintains transnational contacts in manifold ways, for instance due to the Euroregion Elbe/Labe and with further private and public stakeholders. Thus, important preconditions and requirements for cross-border disaster risk management and spatial planning are made due to the mutual exchange of information and agreements (cf. RPV OEOE, 2017: 16f.). However, the research has shown that the majority of the cooperations take place with regard to flood risk management or flood prevention and to a wide lesser extent for other hazards.

3.2 Innovative governance structures for DRM and CCA, especially including spatial planning

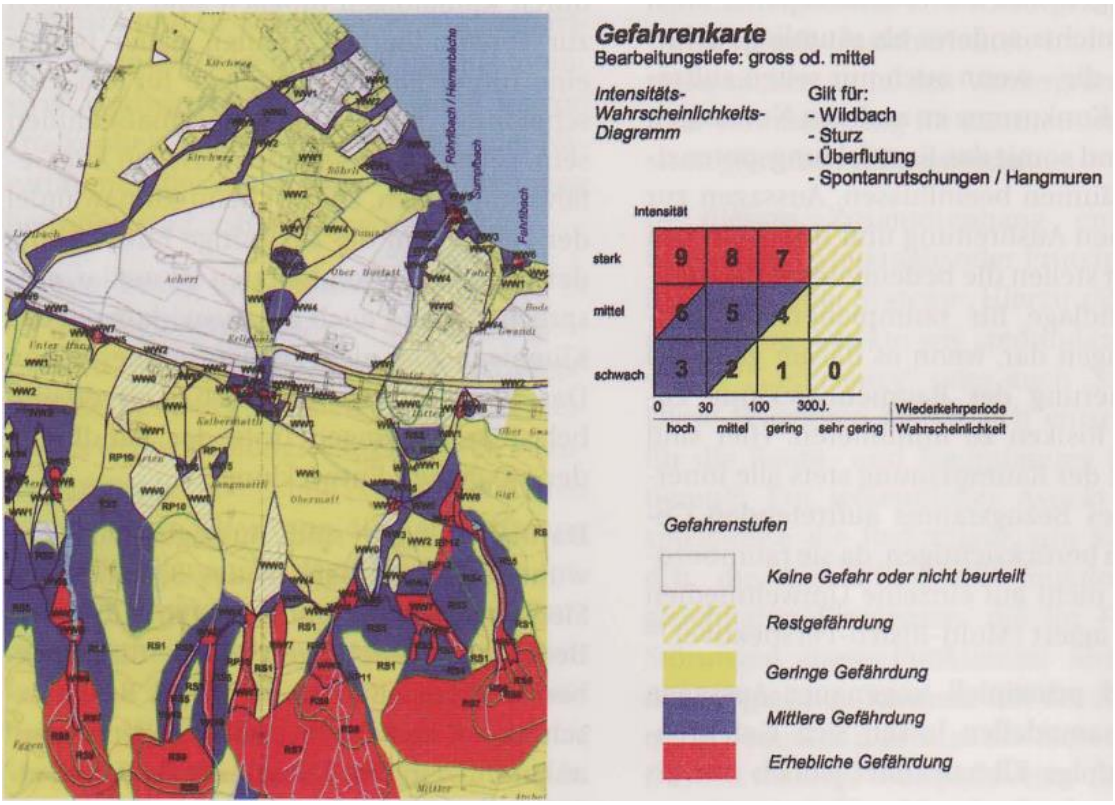
This section aims to provide an overview and analysis how to overcome challenges that are encountered when dealing with the prevention of natural risks at different territorial scales. The analysis along the existing meta-studies, however, did not reveal in-depth insights. Further, it could be observed that some of the good practice examples described in comparative/planning studies turned out to be only theoretically good practice – at a closer look they turned out to be suggestions that were developed in research projects but have never been implemented in planning practice (e.g. the KLIMAPAKT project in Germany). When trying to go more deeply into detail it was found that limited access to documents and/or language barriers hindered to describe general findings from the assessed countries. Thus, additional findings regarding innovative governance structures and planning approaches were derived from the case study analyses (see Annex 5):

- Integration of DRM and CCA in planning laws: e.g., AT, DE, DK (for floods)
- Primary integration of risk assessment and management into spatial planning processes: NL (floods), SE (floods, others)
- Specific planning instruments, incl. EIA: BE, FI, NL (floods)
- Territorial approach/multi-hazard zoning as a basis for planning decisions: AT, CH [see example below], FR
- Specific sectoral management plans and instruments: e.g., AT, IS, IT (floods), FI (storms), SE (others)
- Innovative strategies (no regret strategies; retreat; burden sharing): not explicitly mentioned or only a very few examples (e.g., retreat in AT, NL, DE)
- Stakeholder involvement: e.g., SE, UK
- Transnational cooperation in hazard assessment and management (Baltic Sea Region, Alpine Region [see example below])
- Integration of climate change in DRM and closer cooperation between DRM and CCA action and concepts: mainly for floods, due to the requirements of the second generation of flood risk management plans (e.g., BG, DK, SE, UK)
- Stakeholder involvement in national approaches (PT/DRM, DE/CCA [see example below])

Switzerland: Territorial approach/multi-hazard zoning as a basis for planning decisions

The Swiss cantons create hazard maps, intensity maps and hazard warning maps and publish them on the cantonal geoportals (BAFU, 2020). The federal government supports the cantons in drawing up and updating hazard maps. The hazard maps of the Swiss cantons illustrate the settlements and transport routes threatened by floods, avalanches and other natural hazards relevant in Switzerland. As an example, a hazard map is inserted (see Figure 3.3), which shows hazards such as flooding, rock falls, torrents and landslides. The hazard map is divided into four hazard levels (based on a hazard intensity and probability matrix) and thus provides a basis for hazard zones in the land-use planning process. The areas marked in red are areas of extensive hazard, so building is generally prohibited. Blue areas show medium hazard where building is allowed if certain hazard-adapted requirements are fulfilled. In the yellow low-hazard areas construction is generally possible without requirements. However, as events with low intensity or very rare events with greater intensity can happen here, sensitive buildings should be established in these areas. The yellow-white parts show areas of residual hazard where dangerous natural processes with only very low probability can happen, but still, sensitive buildings should not be established.

Figure 3.3 Cantonal hazard map in Switzerland as a basis for hazard zoning informing preparatory land-use planning in Switzerland (Loat, 2008 in Overbeck et al., 2008: 369)



Alpine Region: Transnational cooperation in hazard assessment and management

Transnational cooperation has a long tradition in the Alpine region (e. g. Alpine Convention, Interreg Alpine Space programme, EUSALP). The Alpine region is characterised by a hazard profile that covers most of the existing natural hazards. At the same time it is – due to its intensive land use and infrastructure network as well as highly sensitive environment – especially vulnerable against natural hazards and climate change. It is thus comprehensible that transnational cooperation should also be practiced in DRM and CCA. All member states strive to reduce the risk of natural hazards to people, infrastructure and settlements. However, the Alpine countries differ considerably in terms of their legal framework, planning system, options for action and finances. For this reason, there is the aim that the countries cooperate more closely and coordinate their actions with regard to natural DRM.

The **Alpine Convention** is an international treaty and since 1991 its aim is to ensure a sustainable and stable development of the Alps. Eight countries and the EU signed the treaty and are working together to overcome common challenges in the Alpine region. Among many other aspects, the two topics climate change and natural hazards are included. An important feature of the Alpine Convention is the partnership approach. This enables cooperation between the local, regional and national levels. The purpose is to increase the efficiency of the Alpine Convention at the local and regional levels. The Alpine Convention's programme for the years 2017-2022 also emphasises the importance of this approach (cf. UBA, 2018: 8). In 2004 the Alpine Convention founded the **Platform on Natural Hazards of the Alpine Convention** (**PLANALP)** as an attempt to better manage these risks. Since then, this platform has provided a basis for an international exchange between all participating countries and the possibility of developing a common risk approach (cf. Schindelegger, 2019; Schindelegger and Kanonier, 2019; Alpine Convention, nd).

A series of other formal documents form a framework for dealing with natural hazards in the Alpine region. These are protocols, which support the goals of the Alpine Convention (BMU, nd). The objectives of spatial planning and sustainable development policy include safeguarding the ecological balance in the Alpine region, protection of special natural landscapes, protection against natural hazards, and many other aspects in consideration with environmental protection. In this context, spatial planning and sustainable development consider the protection against natural hazards to be one of the most important objectives of spatial planning policy. In achieving these objectives, international cooperation between local and regional players in the Alpine region must be strengthened and promoted (cf. Alpine Convention, nd). The Protocols on Mountain Farming and Mountain Forests consider the issue of natural hazards with a view to safeguarding and promoting mountain farming. It emphasises the importance of forests and their role in the prevention of natural hazards (cf. Alpine Convention, nd). The Protocol on Soil Conservation also strengthens prevention of natural hazards by means of international cooperation in the preparation of soil registers, the designation of protected areas and hazard zones, which significantly improves risk management (cf. Alpine Convention, nd). In addition to the legal framework, the Alpine

Convention promotes a wide range of activities that are used for the management of natural hazards. One of these is the Water Platform, which has taken a broad approach to natural hazards, especially with regard to their impact on water management. The Mountain Forests Working Group highlights the importance of Alpine forests and their protective function against natural hazards. With these initiatives, the cross-sectoral efforts of the Alpine Convention in the field of natural hazards becomes visible (cf. Schindelegger, 2019: 25).

The macro-regional EU Alpine Strategy **EUSALP** aims at introducing innovative initiatives in the areas of trade, industry and energy, infrastructure, traffic as well as environmental and resource protection through cooperation between the Alpine states and regions, but also with non-state actors. The Working Group 8 of the EUSALP strategy aims at international cooperation, networking and knowledge exchange and has a funding-based character, e. g. funded by the Interreg projects AlpGov and AlpGov II. The **Work Group 8** considers DRM as well as CCA in its work with a special focus on spatial planning and spatial development strategies (cf. Heil, 2020). PLANALP and Working Group 8 of EUSALP contribute to transnational risk management by information and knowledge exchange and other transnational images (cf. Bartol, 2020; Schindelegger, 2020; Heil, 2020).

The abovementioned Platform PLANALP is not only a basis for integrated DRM, but also the first pan-Alpine framework for **CCA** with regard to natural hazards. It develops strategic objectives and recommendations, which follow an integrated approach and provide strategies for risk management under changing climate conditions. In 2009, the Alpine Convention adopted the Climate Action Plan. It is a transnational strategy and ensures the strengthening of the Alpine Convention by promoting the adaptation of the Alpine region to climate change. The plan is thus the only politically significant transnational policy document to date that covers both adaptation to climate change and mitigation options. Although the document has no legally binding character, the Plan supports the objectives of the Alpine Convention and therefore the implementation of its measures is mandatory for the Member States (cf. Probst and Hohmann, 2019: 8).

The case study analysis showed that long-lasting, sustainable and effective cooperation has to be built on formal agreements but can only be filled with life in an atmosphere of personal connections, mutual trust as well as open-mindedness to share experiences and learn from others as it is promoted in the PLANALP working group of the Alpine Convention and the Working Group 8 of the EUSALP strategy (cf. Papež, 2020; Schindelegger, 2020; Heil, 2020).

Apart from the successful work of the knowledge exchange and information related working groups, it seems difficult to agree on and establish standardised and/or harmonised risk assessment data, methods or tools – even though the need for cooperation also in this field is well-acknowledged and one can build on long-lasting cooperations and mutual trust among the representatives of the other countries. But the analysis showed that at the transnational/supranational level, no guidelines yet exist that lead to the standardisation of risk assessment in the Alpine countries. Rather, obstacles arise from the fact that these

assessments are carried out individually at the national level and are therefore not comparable: “All member states of the Alpine Convention have developed certain types of hazard and risk maps using different colour codes and reference events as a basis. This makes it difficult to compare them” (cf. Schindelegger, 2019: 40). Harmonisation of methods and data is seen to be difficult because each country has its own hazard and risk profile as well as its own approach and logic regarding methods and data (different hazard profiles, needs, administrative system and legislation; often result of historic developments). Thus all countries have their own DRM and CCA methods which make a comparison of assessment results difficult (cf. Schindelegger, 2020; Heil, 2020).

Germany: Stakeholder involvement in national approaches

In order to support the work on the 2nd German-wide climate change vulnerability assessment (Adelphi et al., 2015) and to involve relevant national stakeholders from the very beginning of the research, the German government decided to install a so called “Vulnerability Network”. For establishing the Vulnerability Network in 2011, the Federal Environment Ministry and the Federal Environment Agency invited all higher federal authorities and institutions to participate in the network and support the vulnerability analysis. 16 authorities and institutions from nine thematic sectors accepted this invitation (see Adelphi et al., 2015: 27f.).

The vulnerability assessment was integrated into a collaborative process, in which all normative settings (prioritisation of effects in the 14 fields of action of the German adaptation strategy, selection of impact models and indicators, evaluation of the significance of the effects) from the Vulnerability Network as a whole (i.e. the research consortium and all federal authorities and institutions involved). The network’s authorities and institutions supported the investigation with data, model results, expert knowledge and assessments within their own resources. The professional public with more than 40 external scientists and stakeholders was also included. In expert workshops relating to specific areas of activity, they were able to validate the climate impact chains developed by the network for the systematic derivation of cause-effect relationships between climatic and socio-economic changes. In addition, external scientists and stakeholders were brought in via expert interviews on the state of research and the discussion of climate impacts and the assessment of adaptive capacity. Further, the federal states – especially the state environment ministries and offices – were involved and informed at various points.

The interdisciplinary way of working in the Vulnerability Network, with its diverse links between technical and general issues as well as interfaces to various committees and actors, naturally also harbored hurdles. These were already evident in the agreement on a common understanding of the term and the description of the system to be considered, in the discussion of the IPCC vulnerability concept versus the disaster risk concept and thus led to longer and deep-going discussions. As a result, decision-making processes often took much longer than expected.

However, the discussion and coordination of such questions was an important prerequisite for a broad acceptance and transparency of the results of the vulnerability analysis. In this respect, the time required was usually to justify. In 2015 the network process and research was finalised and the study published and presented to the public and policy makers (adelphi et al., 2015).

References

Adelphi, PRC and EURAC (2015) Vulnerabilität Deutschlands gegenüber dem Klimawandel. Umweltbundesamt: Climate Change 24/2015. Dessau-Roßlau.

Alpine Convention (nd) Protocols and Declarations. Available at: https://www.alpconv.org/en/home/convention/protocols-declarations/ (accessed 24.10.2020).

BAFU - Bundesamt für Umwelt (2020) Gefahrenkarten, Intensitätskarten und Gefahrenhinweiskarten. Available at: https://www.bafu.admin.ch/bafu/de/home/themen/naturgefahren/fachinformationen/naturgefahrensituation-und-raumnutzung/gefahrengrundlagen/gefahrenkarten--intensitaetskarten-und-gefahrenhinweiskarten.html (accessed 24 October 2020).

BAFU - Bundesamt für Umwelt (nd) Daten, Karten und Indikatoren. Available at: https://www.bafu.admin.ch/bafu/de/home/zustand.html (accessed 24 October 2020)

Bartol B (2020) Slovenian delegation in Permanent Committee of Alpine Convention. Ministry of Environment and Spatial Planning, Directorate for Spatial Planning, Construction and Housing. Ljubljana, Slovenia. 12 August 2020.

BMI and BBSR – Bundesministerium des Innern, für Bau und Heimat and Bundesinstitut für Bau-, Stadt- und Raumforschung (eds) (2020) Testlauf Bundesraumordnungsplan Hochwasserschutz (Phase 2), Testplan. Available at: https://www.bbsr.bund.de/BBSR/DE/FP/MORO/Studien/2018/testlauf-brop-hochwasserschutz/dl-brphp2-testplan.pdf?__blob=publicationFile&v=3 (accessed 4 June 2020).

BMU – Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (nd) Presidency of Alpine Convention. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Available at: https://www.bmu.de/en/topics/europe-international-sustainability-digitalisation/international-environmental-policy/alpine-convention/ (accessed 23 October 2020).

BMVBS – Bundesministerium für Verkehr, Bau und Stadtentwicklung (2013) KlimaMORO Infobrief. Ausgabe 04/2013. Available at: https://www.raum-energie.de/fileadmin/Downloads/Projekte/KlimaMORO/Phase_II/17_KlimaMORO_Phase-2_Infobrief4.pdf (accessed 27 October 2020).

BMVI - Bundesministerium für Verkehr und digitale Infrastruktur (ed) (2017) Handbuch zur Ausgestaltung der Hochwasservorsorge in der Raumordnung. MORO Regionalentwicklung und Hochwasserschutz in Flussgebieten. Berlin, Bonn: Bundesministerium für Verkehr und digitale Infrastruktur (BMVI), Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) im Bundesamt für Bauwesen und Raumordnung (BBR). MORO-Praxis No. 10.

CoR – European Committee of the Regions (2016a): Implementation of the Sendai Framework at the EU level: the take-up of resilience measures by Local and Regional Authorities. DOI: 10.2863/301173. Available at: https://cor.europa.eu/en/engage/studies/Documents/Implementation%20of%20the%20Sendai%20Framework%20at%20the%20EU%20level.pdf (accessed 27 October 2020).

CoR – European Committee of the Regions (2016b) Regional and Local Adaptation in the EU since the Adoption of the EU Adaptation Strategy in 2013. Available at: https://cor.europa.eu/en/engage/studies/Documents/Local%20and%20regional%20adaptation.pdf (accessed 14 November 2019).

De Groeve T, Poljanšek K, Ehrlich D and Corbane C (2014) Current status and Best Practices for disaster Loss Data recording in EU Member States - A comprehensive overview of current practice in the EU Member States. ISPRA: JRC Scientific and Policy Reports. DOI:10.2788/18330. Available at: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC92290/lbna26879enn.pdf (accessed 17 June 2020).

EC - European Commission (2009) A Community approach on the prevention of natural and man-made disasters. Available at: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0082:FIN:EN:PDF (accessed 18 October 2019).

EC - European Commission (2010) Risk Assessment and Mapping Guidelines for Disaster Management. Brussels: Commission Staff Working Paper. 21.12.2010, SEC(2010) 1626 final.

EC - European Commission (2013) The EU Strategy on adaptation to climate change: Strengthening Europe's resilience to the impacts of climate change. Available at: https://ec.europa.eu/clima/sites/clima/files/docs/eu_strategy_en.pdf (accessed 6 October 2019).

EC - European Commission (2014) Regulation (EU) No 661/2014 of the European Parliament and of the Council of 15 May 2014 amending Council Regulation (EC) No 2012/2002 establishing the European

Union Solidarity Fund. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0661&from=EN (accessed 6 October 2019).

EC - European Commission (2017) Overview of Natural and Man-made Disaster Risks the European Union may face. Brussels: Commission Staff Working Document. 23.05.2017. SWD(2017) 176 final. Available at: https://ec.europa.eu/echo/sites/echo-site/files/swd_2017_176_overview_of_risks_2.pdf (accessed 6 September 2019).

EC - European Commission (2019): The European Green Deal. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM(2019) 640 final. Brussels. Available at: https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF (12.04.2021).

EC – European Commission (2020): Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing the framework for achieving climate neutrality and amending Regulation (EU) 2018/1999 (European Climate Law). COM/2020/80 final. Brussels. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020PC0080&from=EN (12.04.2021).

EC – European Commission (2021): Forging a climate-resilient Europe – the new EU Strategy on Adaptation to Climate. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM(2021) 82 final. Brussels. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0082&from=EN (12.04.2021).

ECA – European Court of Auditors (2018) Floods Directive: Progress in assessing risks, while planning and implementation need to improve. Special Report No. 25 (pursuant to Article 287(4), second subparagraph, TFEU).

EEA – European Environment Agency (2015) Climate change adaptation and disaster risk reduction in Europe - Enhancing coherence of the knowledge base, policies and practices. European Copenhagen: EEA Technical report No 5/2015.

EEA – European Environment Agency (2017) Climate change adaptation and disaster risk reduction in Europe - Enhancing coherence of the knowledge base, policies and practices. Copenhagen. EEA Report No 15/2017.

EM-DAT (2020) The Emergency Events Database. Université Catholique de Louvain (UCLouvain). CRED, Guha-Sapir D. Brussels, Belgium. Available at: www.emdat.be (accessed 27 February 2019).

EU - European Union (2007) Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the Assessment and Management of Flood Risks. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007L0060&from=EN (accessed 18 June 2020).

EU - European Union (2011) Territorial Agenda of the European Union 2020: Towards an Inclusive, Smart and Sustainable Europe of Diverse Regions. Available at: https://ec.europa.eu/regional_policy/sources/policy/what/territorial-cohesion/territorial_agenda_2020.pdf (accessed 6 October 2019).

EXCIMAP (2007) Handbook on good practices for Flood Mapping in Europe. European Exchange Circle on Flood Mapping (EXCIMAP). Available at: http://ec.europa.eu/environment/water/flood_risk/flood_atlas/pdf/handbook_goodpractice.pdf (accessed 25 May 2020).

GFCE-MERIDIAN – Global Forum on Cyber Expertise, Meridian Process (2016) The GFCE-MERIDIAN Good Practice Guide on Critical Information Infrastructure Protection for governmental policymakers. Available at: https://www.meridianprocess.org/siteassets/meridian/gfce-meridian-gpg-to-ciip.pdf (accessed 25 May 2020).

Greiving S, Zebisch M, Schneiderbauer S, Lindner C, Lückenkötter J, Fleischhauer M, Buth M, Kahlenborn W and Schauser I (2015): A consensus based vulnerability assessment to climate change in Germany. International Journal of Climate Change Strategies and Management. Volume 7 Issue 3: 306 - 326.

Greiving S, Hartz A, Saad S, Hurth F and Fleischhauer M (2016) Developments and Drawbacks in Critical Infrastructure and Regional Planning. Journal of Extreme Events 3(4), 1650014.

Heil K (2020) Interview with Kilian Heil. Bundesministerium für Landwirtschaft, Regionen und Tourismus, Sektion III - Forstwirtschaft und Nachhaltigkeit, Abteilung III/4 - Wildbach- und Lawinenverbauung und Schutzwaldpolitik. Vienna, Austria. 3 September 2020.

JRC Risk Data Hub (nd) Website of the Risk Data Hub. Available at: https://drmkc.jrc.ec.europa.eu/risk-data-hub#/ (accessed 25 May 2020).

Korndörfer C (2020) Interview with Dr. Christian Korndörfer. Landeshauptstadt Dresden, Amt für Umweltschutz, ehem. Amtsleiter. Dresden, Germany.18 August 2020.

Loat R (2008) Gefahrenkarte in der Schweiz. BAFU - Bundesamt für Umwelt. Bern, Schweiz. In: Overbeck G, Hartz A and Fleischhauer M (eds) Ein 10-Punkte-Plan "Klimaanpassung". Raumentwicklungsstrategien zum Klimawandel im Überblick. In: Informationen zur Raumentwicklung. No 6/7: 363-380. ISSN 0303-2493.

Overbeck G, Hartz A and Fleischhauer M (2008) Ein 10-Punkte-Plan "Klimaanpassung". Raumentwicklungsstrategien zum Klimawandel im Überblick. Informationen zur Raumentwicklung. No 6/7: 363-380. ISSN 0303-2493.

Papež J (2020) Interview with Jože Papež. Hidrotehnik Vodnogospodarsko podjetje d.o.o. Ljubljana, Slovenia. 1 September 2020.

Poljanšek K, Marin-Ferrer M, De Groeve T and Clark I (2017) Science for disaster risk management 2017: knowing better and losing less. Luxembourg: Publications Office of the European Union. EUR 28034 EN. DOI: 10.2788/842809, JRC102482.

Poljanšek K, Casajus-Valles A, Marin-Ferrer M, De Jager A, Dottori F, Galbusera L, Garcia-Puerta B, Giannopoulos G, Girgin S, Hernandez-Ceballos M, Iurlaro G, Karlos V, Krausmann E, Larcher M, Lequarre A, Theocharidou M, Montero-Prieto M, Naumann G, Necci A, Salamon P, Sangiorgi M, Sousa M-L, Trueba-Alonso C, Tsionis G, Vogt J and Wood M (2019) Recommendations for National Risk Assessment for Disaster Risk Management in EU. Luxembourg: Publications Office of the European Union. EUR 29557 EN 2019. DOI:10.2760/084707. JRC114650.

Poljansek K, Casajus Valles A, Marin Ferrer M, Artes Vivancos T, Boca R, Bonadonna C, Branco A, Campanharo W, De Jager A, De Rigo D, Dottori F, Durrant T, Estreguil C, Ferrari D, Frischknecht C, Galbusera L, Garcia Puerta B, Giannopoulos G, Girgin S, Gowland R, Grecchi R, Hernandez Ceballos M A, Iurlaro G, Kampourakis G, Karlos V, Krausmann E, Larcher M, Lequarre A S, Libertà G, Loughlin S C, Maianti P, Mangione D, Marques A, Menoni S, Montero Prieto M, Naumann G, Necci A, Jacome Felix Oom D, Pfieffer H, Robuchon M, Salamon P, Sangiorgi M, San-Miguel-Ayanz J, Raposo De M. Do N. E S. De Sotto Mayor M L, Theocharidou M, Theodoridis G, Trueba Alonso C, Tsionis G, Vogt J, Wood M (2021) Recommendations for National Risk Assessment for Disaster Risk Management in EU, EUR 30596 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-30256-8 (online),978-92-76-30257-5 (print), doi:10.2760/80545 (online),10.2760/43449 (print), JRC123585.

Probst T and Hohmann R (2019) Climate Adaptation Governance in the Alpine Space Transnational Synthesis Report (WP1). Zürich. Available at: https://www.capa-eusalp.eu/geonetwork/srv/api/records/1f915839-d671-459c-9be4-6623e0fe066b/attachments/GoApply_D.T1.2.1_D.T1.3.1_WP1_Transntional%20Synthesis%20Report_FOEN-WSL_Feb%202019.pdf (accessed 24 October 2020).

RPV OEOE - Regionaler Planungsverband Oberes Elbtal/Osterzgebirge (ed) (2017) Regionalplan Oberes Elbtal/Osterzgebirge 2. Gesamtfortschreibung. Beteiligungsentwurf (Stand 09/2017) für das Verfahren nach §§ 9 und 10 ROG i. V. m. § 6 Abs. 2 SächsLPlG (freigegeben durch Beschluss der Verbandsversammlung am 14.09.2017) am 24. Juni 2018 verabschiedet. Available at: http://rpv-elbtalosterz.de/wp-content/uploads/Regionalplan_Text.pdf (assessed 27 October 2020).

RPV OEOE - Regionaler Planungsverband Oberes Elbtal/Osterzgebirge (2020) Karte 4 Vorbeugender Hochwasserschutz. Regional Plan Oberes Elbtal/Osterzgebirge 2. Gesamtfortschreibung 2020. Available at: https://rpv-elbtalosterz.de/regionalplanung/regionalplan-2020 (accessed 17 November 2020).

Schindelegger A (2019) Natural Hazard Risk Governance. Report on the state of the Alps. Permanent Secretariat of the Alpine Convention. Alpine Signals – Special Edition 7. Available at https://www.alpconv.org/fileadmin/user_upload/Publications/RSA/RSA7_EN.pdf (25 October 2020).

Schindelegger A (2020) Interview with Arthur Schindelegger. Forschungsbereich Bodenpolitik und Bodenmanagement, Institut für Raumplanung, Technische Universität Wien. Vienna, Austria. 3 September 2020.

Schindelegger A and Kanonier A (2019) Natural Hazard Risk Governance: Status Quo in the EUSALP Region. EUSALP Action Group 8. Available at: https://www.alpine-space.eu/projects/alpgov/deliverables/ag8/ag8-t3.1.1_natural_hazard_risk_governance_final_report_english.pdf (accessed 20 May 2020).

Seifert P (2020) Interview with Peter Seifert. Regionaler Planungsverband Oberes Elbtal/Osterzgebirge. Radebeul, Germany. 4 August 2020.

UBA – Umweltbundesamt (2018) Background Paper: Green economy in the Alps. German Environment Agency. Dessau-Roßlau. Germany. Available at: https://www.umweltbundesamt.de/sites/default/files/medien/376/publikationen/hg_alpenraum_en_bf_low_final.pdf (accessed 20 October2020).

UNISDR - United Nations International Strategy for Disaster Reduction (2015) Sendai Framework for Disaster Risk Reduction 2015 – 2030. UN Office for Disaster Risk Reduction (UNDRR). Geneva, Switzerland. Available at: https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf (accessed 18 June 2020).

Van Ruijven BJ, Levy MA, Agrawal A, Biermann F, Birkmann J and Carter TR (2014) Enhancing the relevance of Shared Socioeconomic Pathways for climate change impacts, adaptation and vulnerability research. Climatic Change. 122 (3): 481–494.

Van Westen CJ and Greiving S (2017) Multi-hazard risk assessment and decision making. In: Dalezios NR (ed) Environmental hazards Methodologies for Risk Assessment and Management. IWA Publishing: 31-94.

Wasser Sachsen (nd) Landeshochwasserzentrum (LHWZ). Available at: https://www.umwelt.sachsen.de/umwelt/wasser/72.htm?hc_location=ufi (accessed 27 October 2020).

Annex A4.1: Assessment table of DRM and CCA practices in Europe (table sent in a separate file)

Country Code	**relevant?** *(1 = yes)*	**ESPON countries** Hazards	**DRM - Assessment** *(assessment of hazards*	**DRM - Management** *(policies on*	**CCA - Assessment** *(assessment of climate*
AT		**Austria**			
AT	1	(1) Floods (river floods, storm surges)	Gefahrenhinweiskarte "Oberflächenabfluss" als	Integration of spatial planning within flood	
AT		(2) Droughts			Investigations into aridity show a three-fold increase
AT	1	(3) Storms (winter, convective)	Natural Hazard Overview and Risk		
AT	1	(4) Earthquakes	Seismic Hazard Map/ Erdbebengefährdungskart		
AT	1	(5) Others (flash floods, land slides)	NO: Coastal flood/ IMPORTANT: Earthquake,	The **GZP/ Hazard Zone Plan for torrent and**	***Slide/Landslide**(Rutschung): The BFW (Bundesforsc
BE		**Belgium**			
BE	1	(1) Floods (river floods, storm surges)	Flemish risk-based approach: Flood Hazard	- Emergency/action plans established	Measurements. Sector Water management
BE		(2) Droughts			Climate impacts are monitored by the

Annex A4.II: Assessment table of the role of spatial planning in DRM in Europe (table sent in a separate file)

Country Code	**ESPON countries** Hazards	**National level** *(role of spatial*	**Regional level** *(role of spatial*	**Local level** *(role of spatial planning in*	**Good practice examples**
AT	**Austria (Österreich)**				
AT	(1) Floods (river floods, storm surges)	The Austrian Conference on Spatial Planning	The 2015 progress report on the implementati	Integration of spatial planning within flood	Clear integration of spatial planning
AT	(2) Droughts				
AT	(3) Storms (winter, convective)				
AT	(4) Earthquakes				
AT	(5) Others (flash floods, land slides)				
BE	**Belgium (Belgien)**				
BE	(0) General information	Horizontal coordination among sectors is	Climate change is not yet completely		
BE	(1) Floods (river floods, storm surges)	The environment al agency in Flanders has	Climate change is mentioned in maritime		
BE	(2) Droughts				

Annex A4.III: References considered for assessment (see tables in Annexes I and II)

Literature

APCC – Austrian Panel on Climate Change - Climate Change Centre Austria (2014) Österreichischer Sachstandsbericht Klimawandel 2014 (AAR14). Verlag der Österreichischen Akademie der Wissenschaften. Wien. Available at: http://www.austriaca.at/APCC_AAR2014.pdf (accessed 19 April 2020).

Ardeleanu L, Leydecker G, Bonjer KP, Busche H, Kaiser D and Schmitt T (2005) Probabilistic seismic hazard map for Romania as a basis for a new building code. *Natural Hazards and Earth System Sciences*. 5. 2005: 679-684. Available at: https://www.researchgate.net/publication/29630015_Probabilistic_seismic_hazard_map_for_Romania_as_a_basis_for_a_new_building_code/link/0912f50f5af6f4f3c7000000/download (accessed 19 May 2020).

Atalić J, Novak Šavor, M and Uroš, M (2019) Seismic risk for Croatia: overview of research activities and present assessments with guidelines for the future. *Građevinar*. 10/2019.

Atalic J, Savor NM and Uros M (2019) Seismic risk for Croatia: overview of research activities and present assessments with guidelines for the future. *Gradevinar*. 10/2019. Available at: https://www.researchgate.net/publication/339644531_Seismic_risk_for_Croatia_overview_of_research_activities_and_present_assessments_with_guidelines_for_the_future (accessed 19 May 2020).

BAFU - Bundesamt für Umwelt (2012) Strategie des Bundesrates zur Anpassung an den Klimawandel in der Schweiz. Available at: https://www.bafu.admin.ch/bafu/de/home/themen/klima/fachinformationen/anpassung-an-den-klimawandel/strategie-des-bundesrates-zur-anpassung-an-den-klimawandel-in-de.html (accessed 23 March 2020).

BMNT - Bundesministerium für Nachhaltigkeit und Tourismus (2018) Hochwasserrisikomanagement in Österreich: Ziele – Maßnahmen – Beispiele. Wien.

BMNT - Bundesministerium für Nachhaltigkeit und Tourismus (2019a) Eigenvorsorge bei Oberflächenabfluss: Ein Leitfaden für Planung, Neubau und Anpassung. Wien.

BMNT - Bundesministerium für Nachhaltigkeit und Tourismus (2019b) Flood risk management in Austria: Objectives, Measures, Good practice. Wien.

Bulgarian Ministry of Environment and Water (2012) Third National Action Plan on Climate Change. For the period 2013 - 2020. Sofia. Available at: https://www.preventionweb.net/files/58313_thirdnationalactionplanfortheperiod.pdf (accessed 19 May 2020).

Bulgarian Ministry of Environment and Water (2019) Appendix 10: Assessment of the Disaster Risk Management Sector. Republic of Bulgaria. Advisory Services on a National Climate Change Adaptation Strategy and Action Plan. Available at: https://www.moew.government.bg/en/climate/international-negotiations-and-adaptation/adaptation/ (accessed 19 May 2020).

Civil Contingencies Secretariat (2017) National Risk Register Of Civil Emergencies. Available at:https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/644968/UK_National_Risk_Register_2017.pdf (accessed 19 May 2020).

Climate Change Committee for Adaptation Malta (2010) National Climate Change Adaptation Strategy. Consultation Report. Available at: https://parlament.mt/media/67383/5790.pdf (accessed 19 May 2020).

CoR – European Committee of the Regions (2016a): Implementation of the Sendai Framework at the EU level: the take-up of resilience measures by Local and Regional Authorities. DOI: 10.2863/301173. Available at: https://cor.europa.eu/en/engage/studies/Documents/Implementation%20of%20the%20Sendai%20Framework%20at%20the%20EU%20level.pdf (accessed 27 October 2020).

CoR – European Committee of the Regions (2016b) Regional and Local Adaptation in the EU since the Adoption of the EU Adaptation Strategy in 2013. Available at: https://cor.europa.eu/en/engage/studies/Documents/Local%20and%20regional%20adaptation.pdf (accessed 14 November 2019).

CoR - European Committee of the Regions 2016c: Regional and Local Adaptation in the EU since the Adoption of the EU Adaptation Strategy in 2013. Available at:

https://cor.europa.eu/en/engage/studies/Documents/Local%20and%20regional%20adaptation.pdf (accessed 14 November 2019).

Cyprus Civil Defence Department (2016) 2nd report on the National Risk Assessment of the Republic of Cyprus. Nicosia. Available at: http://www.moi.gov.cy/moi/cd/cd.nsf/All/0C74FEE8301614EAC2257F16002D8656/$file/2ND%20NRA%20REPORT_CYPRUS.pdf (accessed 19 May 2020).

Danish Nature Agency (2012) Mapping climate change - barriers and opportunities for action. Background Report. Task Force on Climate Change Adaptation. Available at: https://en.klimatilpasning.dk/media/600858/130206_mapping_climate_change_final.pdf (accessed 19 May 2020).

Defra - Department for Environment, Food & Rural Affairs (2017) UK Climate Change Risk Assessment 2017. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/584281/uk-climate-change-risk-assess-2017.pdf (accessed 15 May 2020).

Defra - Department for Environment, Food and Rural Affairs (2011) Understanding the risks, empowering communities, building resilience - The national flood and coastal erosion risk management strategy for England. Presented to Parliament pursuant to Section 7 of the Flood and Water Management Act 2010. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/228898/9780108510366.pdf (accessed 15 May 2020).

DEMA - Danish Emergency Management Agency (2017) National Risk Profile for Denmark. Available at: https://brs.dk/globalassets/brs---beredskabsstyrelsen/dokumenter/krisestyring-og-beredskabsplanlagning/2020/-national_risk_profile_for_denmark_2017_lowres-.pdf (accessed 14 May 2020).

Department of Environment (2016) Climate Change Risk Assessment. Contract No. 22/2014. The Cyprus Climate Change Risk Assessment. Evidence Report. Nikosia. Available at: http://www.moa.gov.cy/moa/environment/environmentnew.nsf/All/C15CD89954708638C2257FF1003494BD/$file/Evidence-Report-FINAL.pdf (accessed 19 May 2020).

Deutscher Bundestag (ed) (2018) Bericht zur Risikoanalyse im Bevölkerungsschutz 2018. Unterrichtung durch die Bundesregierung. Drucksache 19/9521. Available at: https://dipbt.bundestag.de/doc/btd/19/095/1909521.pdf (accessed 15 May 2020).

Direction Générale de la Prévention des Risques (DGPR) (2014) National Strategy for Flood Risk Management. Available at: https://www.ecologique-solidaire.gouv.fr/sites/default/files/2014_Strategie_nationale_gestion_risques_inondations.pdf (accessed 19 May 2020).

Earth Science Institute SAS (2020) National Network of Seismic Stations. Available at: http://www.geo.sav.sk/en/structure-of-the-institute/laboratories/national-network-of-seismic-stations/ (accessed 19 May 2020).

EC - European Commission (2009) The economics of climate change adaptation in EU coastal areas. Available at: https://ec.europa.eu/maritimeaffairs/documentation/studies/climate_change_en (accessed 15 May 2020).

EC - European Commission (2012) Report from the Commission to the European Parliament and the Council on the Implementation of the Water Framework Directive (2000/60/EC). Member State: Hungary. Brussels. 2012. Available at: https://ec.europa.eu/environment/water/water-framework/pdf/3rd_report/CWD-2012-379_EN-Vol3_HU.pdf (accessed 15 May 2020).

EC - European Commission (2014) Assessment of Flood Hazard and Flood Risk Maps. Member State Report: EE – Estonia. Background to the PFRA European Overview – UC10508. Available at: https://ec.europa.eu/environment/water/flood_risk/pdf/fhrm_reports/EE%20FHRM%20Report.pdf (accessed 12 May 2020).

EC - European Commission (2015a) Assessment of Flood Hazard and Flood Risk Maps. Member State Report: HR – Croatia. Background to the PFRA European Overview – UC10508. Available at: https://ec.europa.eu/environment/water/flood_risk/pdf/fhrm_reports/HR%20FHRM%20Report.pdf (accessed 12 May 2020).

EC - European Commission (2015b) Assessment of Flood Hazard and Flood Risk Maps. Member State Report: PT – Portugal. Background to the PFRA European Overview – UC10508. Available at: https://ec.europa.eu/environment/water/flood_risk/pdf/fhrm_reports/PT%20FHRM%20Report.pdf (accessed 12 May 2020).

EC - European Commission (2016a) Current practice in preparing a Preliminary Flood Risk Assessment as required under Article 4 of the Floods Directive. First Draft. April 2016. Available at: https://circabc.europa.eu/sd/a/6f0102d9-bcd8-4760-861c-72c00d969e52/Current%20practice%20in%20select%20MSs_Preliminary%20Flood%20Risk%20Assessment_19%20April%202016_CIRCABC.pdf (accessed 19 May 2020).

EC - European Commission (2016b) Preliminary Flood Risk Assessment. Czech Republic. Available at: https://circabc.europa.eu/webdav/CircaBC/env/wfd/Library/framework_directive/thematic_documents/flood_management/information_exchange/documents_information/preliminary_25-2652009/papers/11_Riha_CZE.pdf (accessed 19 May 2020).

EC - European Commission (2018a) EU Adaptation Strategy - Adaptation preparedness scoreboard. Country fiche available for every European state. Available at: https://ec.europa.eu/clima/policies/adaptation/what_en (14 May 2020).

EC - European Commission (2018b) Science for Environment Policy. Scientists calculate risks of further earthquakes from gas drilling in Groningen, the Netherlands. Issue 511. Available at: https://ec.europa.eu/environment/integration/research/newsalert/pdf/scientists_calculate_risks_further_earthquakes_gas_drilling_groningen_netherlands_511na5_en.pdf (accessed 19 May 2020).

EC - European Commission (2019a) Denmark. Country fiche. Available at: https://ec.europa.eu/environment/water/participation/map_mc/countries/denmark_en.htm (accessed 19 May 2020).

EC - European Commission (2019b) Estonia. Country fiche. Available at: https://ec.europa.eu/environment/water/participation/map_mc/countries/estonia_en.htm (accessed 19 May 2020).

ECA - European Court of Auditors (2018) Floods Directive: progress in assessing risks, while planning and implementation need to improve. Luxembourg. Available at: https://www.eca.europa.eu/Lists/ECADocuments/SR18_25/SR_FLOODS_EN.pdf (accessed 14 November 2019).

EEA - European Environment Agency (2012) Ecological impacts of flooding in the Dijle catchment upstream of Leuven (Belgium). Available at: https://www.eea.europa.eu/data-and-maps/figures/ecological-impacts-of-flooding-in (accessed 19 May 2020).

EEA - European Environment Agency (2017) Climate change adaptation and disaster risk reduction in Europe. Enhancing coherence of the knowledge base, policies and practices. Copenhagen. Available at: https://www.eea.europa.eu/publications/climate-change-adaptation-and-disaster/ (accessed 23 March 2020).

Environment Agency UK (2017) Drought response: Our framework for England. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/625006/LIT_10104.pdf (accessed 15 May 2020).

Estrela T and Vargas E (2012) Drought Management Plans in the European Union. The Case of Spain. *Water Resources Management*. 26:1537-1553. Available at: https://link.springer.com/content/pdf/10.1007/s11269-011-9971-2.pdf (accessed 19 May 2020).

EU Policy Research Corporation (nd) 19. Spain. The economics of climate change adaptation in EU coastal areas. Country overview and assessment. Available at: https://ec.europa.eu/maritimeaffairs/sites/maritimeaffairs/files/docs/body/spain_en.pdf (accessed 19 May 2020).

Federal Ministry for Sustainability and Tourism (2017) The Austrian strategy for adaptation to climate change. Part 1. Context. Vienna.

Federal Ministry for Sustainability and Tourism (2019) The Austrian strategy for adaptation to climate change. Part 2. Action Plan. Updated Version, January 2017. Vienna.

Gibson AD, Culshaw M, Foster C and Pennington C (2012) Landslide management in the UK—the problem of managing hazards in a 'low-risk' environment. *Landslides.* 10 (2013): 599–610. Available at: https://link.springer.com/article/10.1007/s10346-012-0346-4 (accessed 19 May 2020).

Graczer Z (ed), Bondár I, Czanik C, Czifra T, Györi E, Kiszely M, Mónus P, Süle B, Szanyi G, Tóth L, Varga P, Wesztergom V and Wéber Z (2018) Hungarian National Seismological Bulletin 2017, Kövesligethy Radó Seismological Observatory, MTA CSFK GGI, Budapest. Available at: http://www.seismology.hu/data/src/bulletins/HNSB_2017.pdf.

Hanssen-Bauer I, Førland EJ, Haddeland I, Hisdal H, Mayer S, Nesje A, Nilsen JEØ, Sandven S, Sandø AB, Sorteberg A and Ådlandsvik B (2017) Climate in Norway 2100 – a knowledge base for climate adaptation. NCCS report no. 1/2017. Available at: https://www.miljodirektoratet.no/globalassets/publikasjoner/M741/M741.pdf (accessed 19 May 2020).

Hervás-Gámez C and Delgado-Ramos F (2019) Drought Management Planning Policy: From Europe to Spain. *Sustainability*. Available at: https://www.researchgate.net/publication/332076109_Drought_Management_Planning_Policy_From_Europe_to_Spain (accessed 19 May 2020).

Holjevac Culinovic M, Pavlovic D and Pandzic K (nd). Drought conditions and management strategies in Croatia. Available at: https://www.droughtmanagement.info/literature/UNW-DPC_NDMP_Country_Report_Croatia_2013.pdf (accessed 19 May 2020).

Icelandic Department of Civil Protection and Emergency Management (2011) National Risk Assessment for Iceland. Executive summary. The National Commissioner of the Icelandic Police - Gudrun Johannesdottir: Available at: https://www.almannavarnir.is/wp-content/uploads/2016/10/NATIONAL-RISK-ASSESSMENT-FOR-ICELAND_.pdf (accessed 19 May 2020).

Internationale Kommission zum Schutz des Rheins (2015) Internationally Coordinated Flood Risk Management Plan for the International River Basin District of the Rhine, Part A. Available at: https://www.iksr.org/fileadmin/user_upload/Dokumente_en/Brochures/FRMP_2015.pdf (accessed 19 May 2020).

Ivanov P, Berov, B, Dobrev N, Varbanov R, Krastanov M, and Frangov G (2017) Analysis and Mapping the Landslide Hazard in Bulgaria. In: Mikos M, Tiwari B, Yin Y and Sassa K (eds): Advancing Culture of Living with Landslides. *Volume 2 - Advances in Landslide Science*. Springer.

Józsa E, Lóczy D, Soldti M, Dragut LD and Szabó J (2019) Distribution of landslides reconstructed from inventory data and estimation of landslide susceptibility in Hungary. *Hungarian Geographical Bulletin*. 68(3): 255-268. Available at: https://ojs3.mtak.hu/index.php/hungeobull/article/view/1314/1319 (accessed 19 May 2020).

Kalsnes B, Nadim F, Hermanns RL, Hygen HO, Petkovic G, Dolva BK, Berg H and Høgvold DO (2016) Landslide risk management in Norway. Available at: (PDF) Landslide risk management in Norway (researchgate.net) (accessed 19 May 2020).

Kellens E, Vanneuville W, Verfaillie E, Meire E, Deckers P and De Maeyer P (2013) Flood Risk Management in Flanders: Past Developments and Future Challenges. Available at: https://www.researchgate.net/publication/257673152_Flood_Risk_Management_in_Flanders_Past_Developments_and_Future_Challenges (accessed 19 May 2020).

Kersting DK (2016) Ministerio de Agricultura, Alimentación y Medio Ambiente. Cambio Climático en el Medio Marino Español: Impactos, Vulnerabilidad y Adaptación. Madrid. Available at: https://www.miteco.gob.es/es/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/kersting_2016_cambio_climatico_medio_marino_tcm30-70535.pdf (accessed 19 May 2020).

Marx S, Barbeito G, Fleming K, Petrovic B, Pickl S, Thieken A and Zeidler M (2017) Synthesis Report on Disaster Risk Reduction and Climate Change Adaptation in Germany. Bonn (ESPRessO). Available at: ESPREssO_Synthesebericht_DKKV_Schriftenreihe_56.pdf.

Member State Report Slovenia (2014) Background to the PFRA European Overview – UC10508. Assessment of Flood Hazard and Flood Risk Maps. Available at: https://ec.europa.eu/environment/water/flood_risk/pdf/fhrm_reports/SI%20FHRM%20Report.pdf (accessed 19 May 2020).

Mihas S, Efstratiadis A, Nikolaou K and Mamassis N (2014) Drought and water scarcity management plan for the Peleponnese river basin districts. In: 12th National Conference “Protection and Restoration of the Environment” Skiathos, Dept. of Civil Engineering and Dept. of Planning & Regional Development, Univ. Thessaly, Stevens Institute of Technology. Available at: https://www.itia.ntua.gr/en/docinfo/1458/ (accessed 19 May 2020).

Ministère de l’Écologie, du Développement durable, des Transports et du Logement (nd) Submersions marines, crues soudaines et ruptures de digues. Available at: http://www.mementodumaire.net/wp-content/uploads/2012/07/Plan-submersions-rapides-fev20111.pdf (accessed 19 May 2020).

Ministerio de Medio Ambiente y Medio Rural y Marino (2008) PNACC - The Spanish National Climate Change Adaptation Plan. Available at: https://www.preventionweb.net/files/58384_thespanishnationalclimatechangeadap.pdf (accessed 19 May 2020).

Ministry of Agriculture (2000) Strategy for Protection against Floods in the Czech Republic. Prague. Available at: http://eagri.cz/public/web/file/365719/Strategy_for_protection_against_floods.pdf (accessed 19 May 2020).

Ministry of Agriculture and Forestry (2014) Finland’s National Climate Change Adaptation Plan 2022. Government Resolution 20 November 2014. Available at: https://mmm.fi/documents/1410837/1888935/MMM-%23193086-v1-

Finland_s_National_climate_Change_Adaptation_Plan_2022.pdf/c2bfec7b-ae73-4247-b666-26a3ed363f99/MMM-%23193086-v1-Finland_s_National_climate_Change_Adaptation_Plan_2022.pdf (accessed 19 May 2020).

Ministry of Environment and Energy, Croatia (2017) Draft Climate Change Adaptation Strategy in the Republic of Croatia for the period to 2040 with a view to 2070 (White book). Available at: Draft CC Adaptation Strategy.pdf (prilagodba-klimi.hr) (accessed 14 May 2020).

Ministry of Environmental Protection and Energy (2017) Draft Action Plan for the period from 2019 to 2023. Zagreb. Available at: http://prilagodba-klimi.hr/wp-content/uploads/docs/Draft%20CC%20Action%20Plan.pdf (accessed 14 May 2020).

Ministry of Regional Development - Bulgaria (2014) Methodology for Geological Risk Assessment. 2014. Available at (only in Bulgarian): https://www.mrrb.bg/static/media/ups/articles/attachments/4893bfa0b49f80a9d8fb8ae2572538e0.pdf (19.05.2020).

Ministry of the Environment – Czech Republic (2015) Strategy on Adaptation to Climate Change in the Czech Republic. Executive Summary. Available at: https://www.mzp.cz/C125750E003B698B/en/strategy_adaptation_climate_change/$FILE/OEOK_Adaptation_strategy_20171003.pdf (accessed 19 May 2020).

Ministry of the Environment – Czech Republic (nd) Experience of the Czech Republic in the Field of Water Management and Natural Hazards. Available at: http://www.geology.cz/extranet-eng/download/experience-water-management_and_natural-hazards.pdf (accessed 19 May 2020).

Ministry of the Environment - Estonia (2017) Climate Change Adaptation Development Plan until 2030. Available at: https://www.envir.ee/sites/default/files/national_adaptation_strategy.pdf (accessed 19 May 2020).

Ministry of the Environment of the Czech Republic (ed) (2014) Vulnerability Assessment of the Czech Republic in relation to climate change. Available at (Czech version): https://www.mzp.cz/C1257458002F0DC7/cz/hodnoceni_zranitelnosti_cr/$FILE/OPUR-hodnoceni_zranitelnosti-20180427.pdf (accessed 19 May 2020).

Ministry of the Interior – Finland (2019) National risk assessment 2018. Helsinki. Available at: http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161351/9_2019_National%20risk%20assessment.pdf (accessed 19 May 2020).

MKRO - Ministerkonferenz für Raumordnung (2013) Raumordnung und Klimawandel.Umlaufbeschluss vom 06.02.2013. Available at: http://www.klimamoro.de/fileadmin/Dateien/Transfer_KlimaMORO/Beratungsmodul/Leitfäden/Leitfäden%20mit%20Maßnahmenvorschlägen%20in%20relevanten%20Handlungsfeldern/MKRO-Handlungskonzept%20der%20Raumordnung%20.pdf (accessed 19 May 2020).

National Adaptation Plan, Piano Nazionale di Adattamento ai Cambiamenti Climatici PNACC (2017) Prima stesura per la consultazione pubblica. Available at: https://www.minambiente.it/sites/default/files/archivio_immagini/adattamenti_climatici/documento_pnacc_luglio_2017.pdf (accessed 19 May 2020).

National Authority for Civil Protection (2015) National progress report on the implementation of the Hyogo Framework for Action (2013-2015).

National disaster risk assessment Slovenia (2016) Report on the national disaster risk assessment. (accessed: 12.04.2020).

Nilgün O (2005) The Risk Profile and Disaster Management System of Turkey. Available at: https://www.researchgate.net/profile/Nilgun_Okay/publication/242126867_THE_RISK_PROFILE_AND_DISASTER_MANAGEMENT_SYSTEM_OF_TURKEY/links/00b7d52f13fa4151ca000000/THE-RISK-PROFILE-AND-DISASTER-MANAGEMENT-SYSTEM-OF-TURKEY.pdf (accessed 19 May 2020).

NORDRESS (2016) Resilience to natural hazards: An overview of institutional arrangements and practices in the Nordic countries. NORDRESS WP6.1 report 3.6.2016. Available at: http://nordress.hi.is/wp-content/uploads/2015/01/WP6-1-report-of-task1-country-review_formatted.pdf , (accessed 19 May 2020).

Norwegian Directorate for Civil Protection (2014) National Risk Analysis. Disasters that may affect Norwegian society. Norway. Available at: nrb_2014_english.pdf (dsb.no) (accessed 19 May 2020).

ÖROK - Österreichische Raumordnungskonferenz (2005) ÖROK-EMPFEHLUNG NR. 52 zum präventiven Umgang mit Naturgefahren in der Raumordnung (Schwerpunkt Hochwasser). Wien.

ÖROK Atlas: Österreichische Raumordnungskonferenz (n.d.). Naturgefahrenmanagement und Raumplanung. Available at: https://www.oerok-atlas.at/oerok/files/summaries/75.pdf (accessed 19 May 2020).

Peer Review Cyprus (2018) Peer review – report Cyprus. Available at: https://ec.europa.eu/echo/sites/echo-site/files/peer_review_-_report_cyprus_2018_v5.pdf (accessed 19 May 2020).

Peer Review Malta (2016) Peer Review Risk Assessment Malta 2016. 2015-2016 Programme for peer reviews in the framework of EU cooperation on civil protection and disaster risk management. Available at: https://ec.europa.eu/echo/sites/echo-site/files/malta_peer_review_report_-_en.pdf (accessed 19 May 2020).

Peer Review Poland (2016) Programme for peer reviews in the framework of EU cooperation on civil protection and disaster risk management 2015-2016. Available at: https://ec.europa.eu/echo/sites/echo-site/files/poland_peer_review_report_-_en.pdf (accessed 19 May 2020).

Peer Review Portugal (2010) 2018-2019 Programme for peer reviews in the framework of EU cooperation on civil protection and disaster risk management. Available at: https://ec.europa.eu/echo/sites/echo-site/files/peer_review_-_report_portugal_final.pdf (accessed 19 May 2020).

Peer Review Report Bulgaria (2015) 2015-2016 Programme for peer reviews in the framework of EU cooperation on civil protection and disaster risk management. Available at: https://ec.europa.eu/echo/sites/echo-site/files/bulgaria_peer_review_report_-_en.pdf (accessed 19 May 2020).

Peer Review Turkey (2015) 2015-2016 Programme for peer reviews in the framework of EU cooperation on civil protection and disaster risk management. Available at: https://ec.europa.eu/echo/sites/echo-site/files/turkey_peer_review_report_-_en.pdf (accessed 19 May 2020).

Pentti V (2008) The Finnish Approach to Seismic Hazard Analysis – Case Loviisa. Available at: https://www.researchgate.net/publication/262698350_The_Finnish_Approach_to_Seismic_Hazard_Analysis_-_Case_Loviisa (accessed 19 May 2020).

Regierung des Fürstentums Liechtenstein (2018) Anpassungsstrategie an den Klimawandel in Liechtenstein. Vaduz. Available at: https://www.llv.li/files/au/anpassungstrategieklimawandel-li.pdf (accessed 19 May 2020).

Republic of Bulgaria (2019) National Climate Change Adaptation Strategy and Action Plan. Advisory Services on a National Climate Change Adaptation Strategy and Action Plan. Available at: https://www.moew.government.bg/en/climate/international-negotiations-and-adaptation/adaptation/ (accessed 19 May 2020).

Republic of Cyprus (2016) Second National Risk Assessment of the Republic of Cyprus. Cyprus Civil Defence Department, Ministry of Interior. Nicosia. Available at: https://civildefence.com.cy/wp-content/uploads/NRA_CYPRUS_2016.pdf (accessed 19 May 2020).

Republic of Slovenia Ministry of the Environment and Spatial Planning (2018) 7th National Communication & 3rd Biennial Report from Slovenia under the United Nations Framework Convention on Climate Change. Available at: https://unfccc.int/sites/default/files/resource/453201_Slovenia-BR3-NC7-1-7NC3BR-EN_v0b%20F.pdf (accessed 19 May 2020).

Rodriguez L, Lasa CI and Simal PD (2014) Ministerio de Agricultura, Alimentación y Medio Ambiente. Cambio Climático en la Costa Española - Documento Resumen. Madrid. Available at: https://www.miteco.gob.es/es/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/2014%20INFORME%20C3E%20final_tcm30-178459.pdf (accessed 19 May 2020).

Sandberg J, Valikangas P and Varpasuo P (2008) The Finnish Approach to Seismic Hazard Analysis – Case Loviisa. Available at: https://www.researchgate.net/publication/262698350_The_Finnish_Approach_to_Seismic_Hazard_Analysis_-_Case_Loviisa (accessed 19 May 2020).

Schenk V, Kottnauer P, Schenkova Z, Guterch B (2000) Earthquake Hazard for the Czech Republic, Poland and Slovakia – Contribution to the ILC/IASPEI Global Seismic Hazard Assessment Program. Available at: https://www.researchgate.net/publication/227084617_Earthquake_Hazard_for_the_Czech_Republic_Poland_and_Slovakia_-_Contribution_to_the_ILCIASPEI_Global_Seismic_Hazard_Assessment_Program (accessed 19 May 2020).

Swedish Civil Contingencies Agency (2019) Natural hazards and Disaster Risk Reduction in Sweden https://www.preventionweb.net/files/64721_naturaldisasters.pdf (accessed 19 May 2020).

Swedish Government (SOU) (2007) Sweden facing climate change - threats and opportunities. Available at: Sweden facing climate change - threats and opportunities - Government.se (accessed 19 May 2020).

Tsiourtis NX (2008) Experiences for drought management plans in Cyprus. In: López-Francos A (ed): Drought management. Scientific and technological innovations. Zaragoza. CIHEAM. Available at: (PDF) Experiences for drought management plans in Cyprus (researchgate.net) (accessed 19 May 2020).

Umweltbundesamt (2019) Monitoringbericht 2019 zur Deutschen Anpassungsstrategie an den Klimawandel. Bericht der Interministeriellen Arbeitsgruppe Anpassungsstrategie der Bundesregierung. Dessau-Roßlau. Available at: Monitoringbericht 2019 zur Deutschen Anpassungsstrategie an den Klimawandel (umweltbundesamt.de) (accessed 19 May 2020).

UNFCCC NC7: United Nations Climate Change: Seventh National Communications. Reports available for the respective UN member states. Available at: https://unfccc.int/NC7 (accessed 14 May 2020).

UNISDR (2005) National Report Lithuania. Available at: https://www.unisdr.org/2005/mdgs-drr/national-reports/Lithuania-report.pdf (accessed 19 May 2020).

United Nations (nd) National report on drought and desertification in Greece. Available at: https://sustainabledevelopment.un.org/content/documents/dsd/dsd_aofw_ni/ni_pdfs/NationalReports/greece/Greece_II_Drought_Desertification.pdf (accessed 19 May 2020).

Veijalainen N, Ahopelto L, Marttunen M and Jääskeläinen J (2019) Severe Drought in Finland: Modeling Effects on Water Resources and Assessing Climate Change Impacts. Basel, Switzerland. Available at: https://www.researchgate.net/publication/332729824_Severe_Drought_in_Finland_Modeling_Effects_on_Water_Resources_and_Assessing_Climate_Change_Impacts (accessed 19 May 2020).

WHO - World Health Organization (2010a) Bulgaria - Seismic Hazard Distribution Map. Available at: http://eatlas.emro.who.int/europe/images/map/bulgaria/bgr-seismic.pdf (accessed 19 May 2020).

WHO - World Health Organization (2010b) Bulgaria – Landslide Hazard Distribution Map. Available at: http://eatlas.emro.who.int/europe/images/map/bulgaria/bgr-landslides.pdf (accessed 19 May 2020).

WMO - World Meteorological Organization and WHO - World Health Organization (2015) Heatwaves and Health. Guidance on Warning-System Development. WMO-No. 1142. Available at: https://www.who.int/globalchange/publications/WMO_WHO_Heat_Health_Guidance_2015.pdf (accessed 19 May 2020).

Websites

AEMET – Agencia Estatal de Meteorología (nd) Spanish State Meteorological Agency. Available at: http://www.aemet.es/en/lineas_de_interes/meteoalerta (accessed 19 May 2020).

BAFU - Bundesamt für Umwelt Schweiz (2020a) Karten der Sturmgefährdung. Available at: https://www.bafu.admin.ch/bafu/de/home/themen/naturgefahren/fachinformationen/naturgefahrensituation-und-raumnutzung/gefahrengrundlagen/karten-der-sturmgefaehrdung.html (accessed 19 May 2020).

BAFU - Bundesamt für Umwelt Schweiz (2020b) Gefährdungskarte Oberflächenabfluss. Available at: https://www.bafu.admin.ch/bafu/de/home/themen/naturgefahren/fachinformationen/naturgefahrensituation-und-raumnutzung/gefahrengrundlagen/oberflaechenabfluss.html (accessed 19 May 2020).

BAFU - Bundesamt für Umwelt Schweiz: Gefahrenkarten. Available at: https://www.bafu.admin.ch/bafu/de/home/themen/naturgefahren/fachinformationen/naturgefahrensituation-und-raumnutzung/gefahrengrundlagen/gefahrenkarten--intensitaetskarten-und-gefahrenhinweiskarten.html (accessed 19 May 2020).

BFW - Bundesforschungszentrum für Wald (nd) Entwicklung eines Frühwarnsystems für Murenereignisse. Available at: https://bfw.ac.at/rz/bfwcms.web?dok=11460 (accessed 19 May 2020).

British Geological Survey (nd) Landslide and seismic hazard maps. Available at: https://www.bgs.ac.uk/landslides/landslideSusceptibility.html (accessed 19 May 2020).

CENALT - Centre d'Alerte aux Tsunami (nd) French tsunami warning centre. Available at: http://www.info-tsunami.fr/ (accessed 19 May 2020).

Civil Protection Department Italy (nd) Available at: http://www.protezionecivile.gov.it/risk-activities (accessed 19 May 2020).

Climate Adapt (nd) Country fiches available on the status quo of CCA for each European state and states belonging to the EEA. Available at: https://climate-adapt.eea.europa.eu/#t-countries (accessed 19 May 2020).

Climateguide Finnland (2018) Finnish platform on climate. Available at: http://ilmasto-opas.fi/en/ (accessed 19 May 2020).

Cyprus Government (2018) European Directive 2007/60/EC and the Cyprus Law on Floods. Available at: http://www.moa.gov.cy/moa/WDD/wfdf.nsf/home_en/home_en?opendocument (accessed 19 May 2020).

Cyprus Government (2018) Implementation of the Floods Legislation. Available at: http://www.moa.gov.cy/moa/WDD/wfdf.nsf/page13_en/page13_en?opendocument (accessed 19 May 2020).

Department of Civil Protection Italy (nd) Prevention. Available at: http://www.protezionecivile.gov.it/national-service/activities/prevention; Tsunami Map Viewer is available: http://www.protezionecivile.gov.it/risk-activities/tsunami-risk/activities (accessed 19 May 2020).

Department of Forests – Cyprus (nd) Website of the Cyprian department of forests. Available at: http://www.moa.gov.cy/moa/fd/fd.nsf/index_en/index_en?OpenDocument (accessed 19 May 2020).

Deutsches Geoforschungszentrum (nd) Die erdbebengerechte Baunorm DIN EN 1998-1/NA (Fassung 2011-01) und die Zuordnung von Orten zu den Erdbebenzonen. Available at: https://www.gfz-potsdam.de/din4149_erdbebenzonenabfrage/ (accessed 19 May 2020).

Dirección General de Protección Civil et Emergencias (nd) Spanish General Directorate of Civil Protection and Emergencies. Available at: http://www.proteccioncivil.es/ (accessed 19 May 2020).

Dynamic Coast (nd) Website of the Dynamic Coast project in the UK. Available at: http://www.dynamiccoast.com/about_project.html (accessed 19 May 2020).

ECONADAPT TOOLBOX (nd) Assessing Flood Risk Management in EU states. Country fiches available for selected member states. Available at: https://econadapt-toolbox.eu/insights (accessed 19 May 2020).

EPA Catchments Unit (nd) Ireland's Catchment Flood Risk Assessment and Management (CFRAM) Programme. Available at: https://www.catchments.ie/irelands-catchment-flood-risk-assessment-and-management-cfram-programme/ (accessed 19 May 2020).

ESKP - Earth System Knowledge Platform (nd) Earthquake early warning system for Istanbul. Available at: https://www.eskp.de/en/natural-hazards/earthquake-early-warning-system-for-istanbul-93569/ (accessed 19 May 2020).

ESKP- Earth System Knowledge Platform (nd) Sturmgefährdung in Deutschland. Available at: https://www.eskp.de/naturgefahren/sturmgefaehrdung-in-deutschland-935265/ (accessed 19 May 2020).

Estrela Monreal T (nd) Drought Management Plans. Presentation. Available at: https://www.riob.org/en/file/259639/download?token=C3rCp7sL (accessed 19 May 2020).

European Civil Protection and Humanitarian Aid Operations - Latvia (2019) Overview of the National Disaster Management System. Available at: https://ec.europa.eu/echo/what/civil-protection/disaster-management/latvia_en (accessed 19 May 2020).

European Civil Protection and Humanitarian Aid Operations (nd) Country fiches with an overview of the National Disaster Management System. Available for selected EU states. Available at: https://ec.europa.eu/echo/what/disaster-management_en (accessed 19 May 2020).

European Commission (2018) Overview of the National Disaster Management System. Available at: https://ec.europa.eu/echo/what/civil-protection/disaster-management/iceland_en (accessed 19 May 2020).

European Commission Disaster Management Country fiche Iceland (nd). Country fiche Iceland European Civil Protection and Humanitarian Aid Operations. Overview of the National Disaster Management System. Available at: https://ec.europa.eu/echo/what/civil-protection/disaster-management/iceland_en (accessed 19 May 2020).

European Commission: Environment country fiche Lithuania. Available at: https://ec.europa.eu/environment/water/participation/map_mc/countries/lithuania_en.htm (accessed 19 May 2020).

Floodinfo.ie (nd) Irish national flood information portal with flood plans and maps. Available at: http://www.floodinfo.ie/ (accessed 19 May 2020).

Forest Cities Project (nd) Forest Cities - Local Authorities Alliance for Forest Fire Prevention in Greece. LIFE08 ENV/GR/000553. Available at: https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3476 (accessed 19 May 2020).

French-Property (nd) Real Estate, Real Living, Real France. Flood Risk Areas in France. Available at: https://www.french-property.com/news/french_property/flood_risk_areas/ (accessed 19 May 2020).

Géorisques (nd): French platform for natural hazards. Available at: https://www.georisques.gouv.fr/dossiers/feux-de-foret (accessed 19 May 2020).

GFDRR - Global Facility for Disaster Reduction and Recovery Turkey (2017) Natural Hazard Risk. Available at: https://www.gfdrr.org/en/turkey (accessed 19 May 2020).

Global Water Partnership Central and Eastern Europe (nd) Integrated Drought Management Programme for Central and Eastern Europe. Available at: https://www.gwp.org/en/GWP-CEE/WE-ACT/Projects/IDMPCEE/ (accessed 19 May 2020).

Government of Iceland, Meteorology and Natural Hazards (nd) Ministry for the Environment and Natural Resources. Available at: https://www.government.is/topics/public-safety-and-security/meteorology-and-natural-hazards/ (accessed 19 May 2020).

Hellenic National Tsunami Warning Centre (nd) Tsunami Warning Centre in Greece. Available at: http://hl-ntwc.gein.noa.gr/services.html (accessed 19 May 2020).

HORA – National Hazard Overview and Risk Assessment Austria (nd) Interactive map on natural hazards in Austria. Available at https://www.hora.gv.at (accessed 19 May 2020).

Hydro Climate Strategy Riga (nd) Integrated Strategy for Riga City to Adapt to the Hydrological Processes Intensified by Climate Change Phenomena. Life08 ENV/LV/000451. Available at: https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3413 (accessed 19 May 2020).

Icelandic Government (nd) Website of the Icelandic government. Available at https://www.government.is/ (accessed 19 May 2020).

Icelandic Met Office online (nd) Website of the Icelandic Meteorological Office. Available at: https://en.vedur.is/ (accessed 19 May 2020).

IGN – Instituto Geográfico Nacional (nd) Spanish National Geographic Institute. Available at: www.ign.es (accessed 19 May 2020).

Irish Water online (nd) Website of the Irish water institute. Available at: https://www.water.ie/water-supply/water-shortages/ https://www.water.ie/projects-plans/our-plans/nwrp/ (accessed 19 May 2020).

ISPRA - Instituto Superiore per la Protezione e la Ricerca Ambientale (2019) Drought bulletin. Italy. Available at: https://www.isprambiente.gov.it/pre_meteo/siccitas/index_en.html (accessed 19 May 2020).

Kennisportaal Ruimtelijke Adaptatie (2018) Knowledge Portal Spatial Adaptation: Delta Plan on Spatial Adaptation 2018. The Netherlands. Available at: https://ruimtelijkeadaptatie.nl/english/policy-programmes/delta-plan-sa/ (accessed 19 May 2020).

KNMI - Koninklijke Nederlands Meteorolgisch Instituut (nd) Seismic hazard maps for Groningen. Available at: https://data.knmi.nl/datasets/seismic_hazardmaps/1 (accessed 19 May 2020).

MET éireann – Irish Meteorological Service. Available at: https://www.met.ie/ (accessed 19 May 2020).

Ministère de la Transition écologique et solidaire (nd) Website of the French Ministry of Ecological Transition. French version. Available at: https://www.ecologique-solidaire.gouv.fr/politiques-publiques (accessed 19 May 2020).

MITECO - Ministerio para la Transición Ecológica y el Reto Demográfico (nd) Spanish Ministry for the Ecological Transition and the Demographic Challenge. Available at: https://www.miteco.gob.es/es/ (accessed 19 May 2020).

NAGiS (nd) Hungarian National Adaptation Geo-information System. Available at: https://nater.mbfsz.gov.hu/en/node/51 (accessed 19 May 2020).

National Planning Agency Iceland (nd) Available at https://www.skipulag.is/en (accessed 19 May 2020).

OCP - Office of Civil Protection in Liechtenstein (2017) Natural Hazard Maps. Available at: http://geodaten.llv.li/geoportal/naturgefahren.html (accessed 19 May 2020).

Office of Public Works (2019) Plan prepare protect. Informative website on floodings. Available at: www.flooding.ie (accessed 19 May 2020).

Office of public works Ireland (nd) Flood Risk Management. Climate Change Sectoral Adaptation Plan 2019. Available at: https://www.gov.ie/pdf/?file=https://assets.gov.ie/46534/3575554721374f7ab6840ee11b8b066a.pdf#page=1 (19.05.2020).

Portugese Environmental Agency (nd) Programas da Orla Costeira. Available at: https://apambiente.pt/index.php?ref=16&subref=7&sub2ref=10&sub3ref=1193(accessed 19 May 2020).

Preventionweb (nd) website. Flood Warning Development Framework. Available at: https://www.preventionweb.net/english/policies/v.php?id=51879&cid=183 (accessed 19 May 2020).

Reliefweb (2018) Turkey's New Earthquake Hazard Map is Published. Available at: https://reliefweb.int/report/turkey/turkeys-new-earthquake-hazard-map-published (accessed 19 May 2020).

Resources Authority Malta (nd) Website. Available at: www.mra.org.mt (accessed 19 May 2020).

RISC KIT (nd) EU Coastal Management – Governance. Case studies available at: https://coastal-management.eu/governance (accessed 19 May 2020).

RO RISK- National Risk Assessment (2016) Available at: https://www.igsu.ro/documente/RO-RISK/Raport_Final_de_tara.pdf (accessed 19 May 2020).

SED - Swiss Seismological Service (nd) Seismic Hazard Swizerland. Available at: http://www.seismo.ethz.ch/en/knowledge/seismic-hazard-switzerland/ (accessed 19 May 2020).

Seismic Monitoring & Research Group (nd) Earthquake viewer. Available at: https://seismic.research.um.edu.mt/ (accessed 19 May 2020).

Seismological Observatory (nd) Seismic maps of Hungary and annual seismic bulletins. Available at: http://www.seismology.hu/index.php/en/seismicity/earthquake-bulletins (accessed 19 May 2020).

SGI – Swedish Geotechnical Institute (nd) Available at: https://www.swedgeo.se/en/samhallsplanering--sakerhet/skredriskkartering/ (accessed 19 May 2020).

SGI – Swedish Geotechnical Institute: Landslide Risk Mappin. Available at https://www.swedgeo.se/en/samhallsplanering--sakerhet/skredriskkartering/ last updated 2018 (accessed 19 May 2020).

South-Transdanubian Water Management Directorate (2015) Hungary’s excess water risk map. Available at: http://ddvizig.hu/en/korabbi-hirek-1-en/f2105a17-69d0-45c0-95cf-ccfad9b01d30 (accessed 19 May 2020).

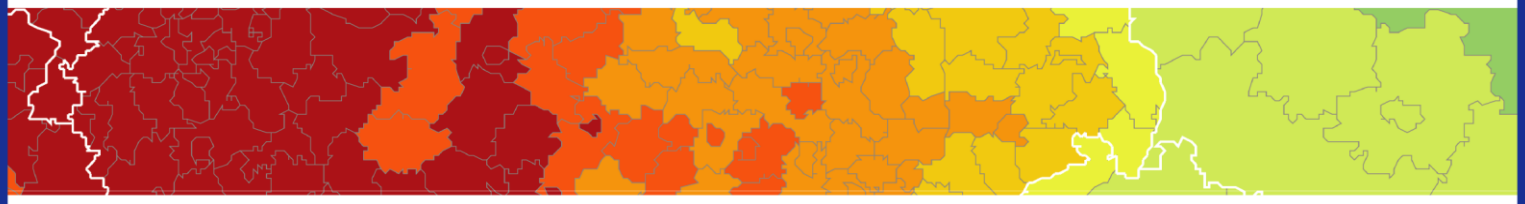
Statistics Finland: Climate change impacts, adaptation measures and vulnerability assessment (nd) Report on Finnish climate and climate change impacts. Available at: https://www.stat.fi/tup/khkinv/nc6_chapter_6.pdf (accessed 19 May 2020).

Térport (nd) National Development and Territorial Development Concept. Hungarian version. Available at: http://www.terport.hu/teruleti-szintek/ketoldalu-egyuttmukodesek/bilateral-cooperation/magyarorszag-ausztria/hungary-aus-3 (accessed 19 May 2020).

Tsunami map viewer Italy (nd) Available at: http://www.protezionecivile.gov.it/risk-activities/tsunami-risk/activities (accessed 19 May 2020).

UK Centre for Ecology and Hydrology (nd) UK drought portal. Available at: https://eip.ceh.ac.uk/droughts (accessed 19 May 2020).

Umweltbundesamt (nd) MEDROPLAN – Mediterranean Drought Preparedness and Mitigation Planning. Available at: https://www.umweltbundesamt.de/en/topics/climate-energy/climate-change-adaptation/adaptation-tools/project-catalog/medroplan-mediterranean-drought-preparedness (accessed 19 May 2020).



ISBN: 978-2-919816-06-4

ESPON 2020 – More information

ESPON EGTC
4 rue Erasme, L-1468 Luxembourg - Grand Duchy of Luxembourg
Phone: +352 20 600 280
Email: **info@espon.eu**
www.espon.eu, **Twitter**, **LinkedIn**, **YouTube**

The ESPON EGTC is the Single Beneficiary of the ESPON 2020 Cooperation Programme. The Single Operation within the programme is implemented by the ESPON EGTC and co-financed by the European Regional Development Fund, the EU Member States, the United Kingdom and the Partner States, Iceland, Liechtenstein, Norway and Switzerland.