



ESPON-TITAN Territorial Impacts of Natural Disasters

Applied Research

**Final Report – Annex 6
Policy recommendations**

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ESPON-TITAN
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Abbreviations

CCA	Climate Change Adaptation
CGE model	Computable General Equilibrium Model
DDM	Damage Distribution Matrix
DRM	Disaster Risk Management
DRMKC	Disaster Risk Management Knowledge Centre
EDO	European Drought Observatory (JRC)
EC	European Commission
EIA	Environmental Impact Analysis
ELSUS	European Landslide Susceptibility
ESDAC	European Soil Data Centre
EM-DAT	Emergency Events Database provided by Centre for Research on the Epidemiology of Disasters
ESPON	European Territorial Observatory Network
ESPON EGTC	ESPON European Grouping of Territorial Cooperation
ETC	Extratropical Cyclones
EU	European Union
FRMD	Flood Risk Management Directive
GDP	Gross Domestic Product
GRETA	GRGreen infrastructure: Enhancing biodiversity and ecosystem services for territorial development
GVA	Gross Value Added
I/O	Input-Output
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Center
MRIO	Multi-Regional Input-Output
NACE	Nomenclature statistique des Activités économiques dans la Communauté Européenne in french, or Statistical Classification of Economic Activities in the European Community
NATECHS	Natural-technical hazards
NRA	National Risk Assessment
NUTS	Nomenclature of Territorial Units for Statistics
PGA	Peak ground acceleration
SCGE model	Spatial Computable General Equilibrium Model
SEA	Strategic Environmental Assessment
SHARE	Seismic Hazard Harmonization in Europe project
SPI	Standardized Precipitation Index
UCPM	Urban Civil Protection Mechanism
UN	United Nations
UNDRR	United Nations Office for Disaster Risk Reduction
UNISDR	United Nations International Strategy for Disaster Reduction
WFD	Water Framework Directive
WISC	Windstorm Information Service

1 Policy recommendations

The ESPON-TITAN policy recommendations cover six topics (Table 1.1), which address different parts or stages of the policy process, namely problem identification and agenda setting, formulation and adoption, implementation, and evaluation (based on e. g. Howlett & Ramesh 1995; Jordan 2002; Burke 2020). Moreover, the suggested policy recommendation topics also cover methodological issues, that receive a deeper consideration on the recommendations for future research (Chapter 2). The policy recommendations mostly concern action at the European level. Since ESPON stakeholders include the national, regional and even local policy makers, we added a specific set of policy recommendations dedicated to those levels was added, as an extraction from the case studies (Chapter 7).

Table 1.1 Contextualization of ESPON-TITAN policy recommendations

Context	Topics covered by the policy recommendation
Economic impacts	(A) How to improve methodologies for calculating the economic costs of disasters and natural hazards and assessing their impact at different territorial scales.
	(B) What could be done to improve data availability on economic losses associated with disasters and natural hazards, especially at local and regional levels.
Connection between economic losses and appropriate DRM and CCA measures	(C) How to link measurement of economic losses due to disasters and natural hazards with the development of appropriate disaster risk management and climate change adaptation measures at different territorial scales.
Improvement of DRM and CCA practices	(D) To what extent can different funding mechanisms (European Structural and Investment Funds, Financial Instruments, etc.) be better mobilised to further support disaster risk management and climate change adaptation at territorial level.
	(E) How should regions, cities and local governments cooperate to ensure the efficiency and coordination of various measures related to disaster risk management and climate change adaptation? What could be a role for different umbrella organizations?
	(F) How to better integrate DRM and CCA into legislative frameworks and instruments of territorial development?

The policy recommendations were collected and described in a first draft, in a discussion paper (11 September 2020) on the basis of the ESPON-TITAN project results, as well as an additional literature and policy documents review. The paper was internally circulated among the research teams and discussed in an internal project workshop, which took place on 16 September 2020 with the participation of all project partners: Tecnalía (represented by Carolina Cantergiani, Efren Feliu, Daniel Navarro), Geological Survey of Finland (Johannes Klein, Marianne Valkama), TU Dortmund University (Stefan Greiving, Mark Fleischhauer), Trinomics (Foivos Petsinaris) and Cambridge Econometrics (Dóra Fazekas, Boglárka Molnár). Finally, the policy recommendations were presented and received feedback in what was considered as a “validation workshop” in the session “Territorial impacts of natural disasters”, which took place on 14 October 2020 as a part of the 18th European Week of Cities and Regions under participation of, among others, Tiberiu-Eugen Antofie (Joint Research Centre, EC), Adriana

May (Lombardy Region, IT) and Marcia van der Vlugt (Ministry of Interior and Kingdom Relations of the Netherlands, NL).

Table 1.2 provides an overview of ESPON-TITAN policy recommendations. Policy recommendations highlighted in orange are described also in the main report. The recommendations highlighted in green refer to methodological recommendations, which are presented in Chapter 2 (Recommendations for future research). As already stated, the policy recommendations are structured around the different stages of the policy process, and the description specifies to which of them the policy recommendation could contribute (problem identification and agenda setting; formulation and adoption; implementation; evaluation).

Table 1.2 Overview of policy recommendations in each group (in orange: PR are also described in the main report, in green: PR described in the section about recommendations for future research)

Economic impacts (methods, data)	
(A) Methodologies for calculating economic costs and impacts of disasters and natural hazards	A-1: Harmonisation of concepts and methods for risk assessment and risk evaluation
	A-2: Further development of appropriate damage functions for different types of hazards including the calculation of uncertainty parameters
	A-3: Research on indirect losses and impacts should increase
	A-4: Support methodological innovations in risk assessments regarding the spatial and temporal dimension of risk
	A-5: Conceptualisation of criticality as a basis for contributing to the evaluation of risk
	A-6: Support regions and the local level in using research and cooperation projects more strategically for DRM and CCA
	A-7: Research on how to consider human losses as additional impact of natural hazards, on their inclusion in decision-making processes
(B) Improve data availability on economic losses from disasters and natural hazards at local and regional levels	B-1: Development of a framework for the collection of the necessary data at the local level across Member States/authorities
	B-2: Disaster-related damage data and reporting should be more granular, including the distinction between direct and indirect damages to avoid double counting in economic modelling
Connection between economic losses and appropriate DRM and CCA measures	
(C) Link measurement of economic losses with the development of DRM and CCA measures	C-1: DRM and CCA measures and plans should always account for the total economic impacts of the occurring natural hazards, including both direct and indirect losses as well as risk aversion factors
	C-2: Support a paradigm shift towards a spatially oriented risk assessment and management by including the spatial (cross-sectoral, multi-risk perspective) and temporal (risk dynamics, emerging risks) dimension of risk
	C-3: Conceptualisation of criticality and consideration of critical infrastructures (CI) in the evaluation of risk (systemic risk/criticality perspective)
Policy recommendations regarding the improvement of DRM and CCA practices (legislation, funding, cooperation)	
(D) Mobilise European funding mechanisms to further support DRM and CCA at territorial levels	D-1: Focused promotion of a pro-active and prevention-oriented design of EU funding instruments in combination with quality objectives regarding funding of reconstruction
(E) Cooperation and coordination of regions, cities and local governments	E-1: Develop cooperation structures between regions, cities and local governments but also between different experts based on a balanced set of formal and informal elements
	E-2: Establish a clear coordination structure for DRM and provide it with leadership qualities
(F) Integration of DRM and CCA into legislative	F-1: Support DRM and CCA issues during amendment processes of EU Directives
	F-2: Mainstreaming climate change adaption in territorial development policies

1.1 Policy recommendations regarding economic impacts (methods, data)

The first block of policy recommendations are related to economic impacts (focused on methods and data), where a general question permanently emerges: the trade-off between high resolution and local/regional accuracy of data on the one hand and, on the other hand, the comparability and homogeneity across all regions and statistical units across the ESPON space. Although there is not an easy-to-achieve solution, this issue is addressed by suggesting standards for the collection of comparable data and transparency in methodological approaches. Further recommendations under this topic refer to methodological innovations and are thus discussed under the research needs section (see Chapter 2).

1.1.1 How to improve methodologies for calculating the economic costs of disasters and natural hazards and assessing their impact at different territorial scales

This section relates mainly to the findings from the hazards and economic impact analysis, as well as from the case studies in relation to the assessment of the local economic impacts (Prague, Charente-Maritime), besides insights from literature. The guiding questions are:

- What are most appropriate methodologies for assessing economic impacts of disasters and natural hazards?
- Which methodological approach is appropriate for which territorial level (EU, national, regional)?
- Relevance and importance to include indirect losses, non-monetary costs, losses due to cascading effects etc.?
- How can negative consequences of disasters be assessed? By vulnerability indicators in the area of concern? What about indirect costs that occur elsewhere? How can these be assessed? How should these be mapped?
- What are the implications of the calculation of economic losses for other policy recommendations (e.g. economic loss thresholds as a criterion for granting funds after disasters or for defining keys for distribution of funds among affected countries)?
- Need and possibility to harmonise methodological approaches across countries or regions?

Policy recommendation no. A-1

Harmonisation of concepts and methods for risk assessment and risk evaluation

Findings from ESPON-TITAN:

The findings from ESPON-TITAN showed that a harmonisation of methods and data are seen to be difficult because each country has its own hazard and risk profile and designs an own approach and logic behind, according to own hazard profile or needs or the national system and legislation (often result of a historic development). Thus, all countries have their own DRM and CCA methods which makes a comparison of assessment results difficult (see Chapter 6 and Chapter 7 “Case studies”; case study interviews Alpine Region, A. Schindelegger, K. Heil). In addition, the different concepts of disaster risk management and climate change adaptation also caused methodological and data-related challenges and showed a need for also integrating climate change more deeply in disaster risk management.

Explanations:

Description of policy recommendation

This policy recommendation contributes to answering the question how to improve methodologies for calculating the economic costs of disasters (and natural hazards) and assessing their impact at different territorial scales. The policy recommendation builds on the remarkable efforts that have been made especially by JRC in recent years, which established the Risk Data Hub that provides and further develops the presentation of comparable spatially differentiated data on disaster risk (Antofie et al., 2019; 2020).

However, any kind of opposition against harmonisation approaches for methods should only be understood against the background of political or resource-related reasons (unwillingness to change long-established methods and procedures, lack of financial or personnel resources to implement new methods). In fact, methodological harmonisation is possible and necessary whenever reliable cross-regional and/or cross-national comparisons/evaluations are required (see policy recommendation F-2), although they do not question the necessity of context-specific risk evaluations as normative judgements and basis for risk management actions.

This is also supported by the recent report on NRAs for DRM (Poljanšek et al., 2021), which recommends that across Europe, risk assessment has to be done in a way to make risks comparable, as the comparability of evidence is the key issue in evidence-based policy making. It is vital to obtain harmonised information in order to create a more accurate picture of the gaps and needs at European level: *“The harmonization of risk metric would allow the comparison of risks across hazards, regions, time, assets or sectors. These would allow aggregation of risks arising from the same hazard and understanding of relative importance of different risks for prioritization of DRM actions. It would establish a common understanding of risks that country is facing when consulting among each other. It would pave the way to the multihazard risk assessment, introducing interactions and cascading effects in modelling, as well as provide some analytical interpretations of compound and systemic risks”* (Poljanšek et al. 2021: 62). The authors of the study further conclude that

“realistically, harmonisation of the risk assessment process shall remain at the level of terminology, data, risk concept, standardized steps of risk assessment process and presentation of the results” (Poljanšek et al. 2021: 14).

Such kind of harmonisation should happen in three steps; each step would mean a higher degree of harmonisation: (1) agreement on the conceptual frame (e.g. risk-based approach or inclusion of residual risk or the inclusion of systemic criticality), (2) agreement on criteria (data quality, complexity, indicators) to guarantee the quality of the assessment/evaluation method, (3) agreement on a specific assessment method. An example how the integration of approaches and data across different territorial levels was implemented is the Climate impact atlas in the Netherlands. Although it is a national (and not European-wide) approach, it shows how various knowledge institutes and consultancies are involved and contribute with source materials (Van der Vlugt, 2020).

The basic differences in risk analysis (based on past events) and climate change impact assessment (based on scenarios) shall not hinder researchers and policy makers to look for consistent, but pragmatic ways to better align both concepts (IPCC report on managing extreme events can still be a starting point).

Specific Action

As a specific action, aligned with the recommendations from Poljanšek et al. (2021), we recommend that the EC puts forward a proposal for a regulation of a harmonisation of concepts and methods for risk assessment and risk evaluation in order to achieve comparable and comprehensive risk assessment and evaluation standards to support DRM policies at European level, e.g. for the further development of the EU Solidarity Fund or for defining funding criteria for supporting infrastructure investments in the Member States. This should be based on an earlier communication of the EC (Commission Staff Working Paper “Risk Assessment and Mapping Guidelines for Disaster Management”, EC 2010) and the expertise and experiences collected since 2017 in the JRC-supported Risk Data Hub under the Disaster Risk Management Knowledge Centre (DRMKC) of the EC. The JRC efforts in this regard should be further extended (several hazards are not yet covered) and the methodology of the approach, the sources used and the constraints could be described more transparently. Further, the accessibility of this information should be improved. The target is thus the EC (including JRC) who should take up the supervisory, e.g. by DG ECHO. Indirectly, also the Member States are addressed that will have to contribute to the harmonisation process and that will have to apply the assessment and evaluation criteria and provide appropriate data. Thus, this policy recommendation contributes to the stage of formulation and adoption within the policy process.

Target and territorial level of policy recommendation

European Commission (including JRC).

Relevance for other policy recommendations

B-1: Development of a framework for the collection of the necessary data at the local level across Member States/authorities (in order to harmonise and streamline and thus increase comparability of results, including harmonised data collection at the local level in the aftermath of a disaster).

D-1: Focused promotion of a pro-active and prevention-oriented design of EU funding instruments in combination with quality objectives regarding funding of reconstruction.

F-2: Mainstreaming climate change adaptation in territorial development policies.

Links and synergies with relevant policies (EU Directives, National policies , etc.)

EU Solidarity Fund; Commission Staff Working Paper “Risk Assessment and Mapping Guidelines for Disaster Management” (EC 2010); JRC-supported Risk Data Hub under the DRMKC – Disaster Risk Management Knowledge Centre of the European Commission.

Link with other ESPON projects (previous or on-going ones)

References

Booth L, Fleming K, Abad J, Schueller LA, Baills A (2020) Simulating synergies between Climate Change Adaptation and Disaster Risk Reduction stakeholders to improve management of transboundary disasters in Europe. *International Journal of Disaster Risk Reduction*, October 2020, p. 101668.

Hemmers J, Pickl S, Schwarze R, Thiebes B, Zuccaro B (2020) Beyond ESPREsO - Integrative Risk Assessment 2025 Synergies and gaps in climate change adaptation and disaster risk reduction. In: *International Journal of Disaster Risk Reduction*, October 2020. In Press, p. 101817.

IPCC (2012) *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. Special Report of the Intergovernmental Panel on Climate Change. (C. B. Field, V. Barros, T. F. Stocker and D. Qin, eds.). Cambridge University Press, Cambridge.

Papathoma-Köhle M, Promper C, Glade TA (2016) Common Methodology for Risk Assessment and Mapping of Climate Change Related Hazards—Implications for Climate Change Adaptation Policies. *Climate* 2016, 4, 8.

1.1.2 What could be done to improve data availability on economic losses associated with disasters and natural hazards, especially at local and regional levels

This section relates mainly to the findings from Tasks 2 and 3 and also the Task 5 case studies with the assessment of economic impacts (Czechia, Charente-Maritimes) as well as insights from literature. Guiding questions:

- Which kind of data shall be provided for which purpose and which territorial level and in which resolution and frequency in order to appropriately assess the economic effects of disasters and natural hazards?
- Who shall provide data?
- Which institutions should cooperate better? Do good practice examples between states or within states?
- Harmonisation of data formats, updates, classifications etc.

Policy recommendation no. B-1

Development of a framework for the collection of data at the local level across Member States/authorities

Findings from ESPON-TITAN:

The databases (the Risk Data Hub, WISC and EM-DAT) used in the ESPON-TITAN project for their information on economic damages per event exhibited several differences in how they collect and harmonise data (see Chapters 2, 3 and 7 with special reference to the case studies Czechia and Charente-Maritimes). The assessment of the economic risk would benefit from more detailed damage information. Small differences in the location of capital stock (location of buildings in our outside flooded areas) can have tremendous effects on the actual damage caused by a hazard. The collection of the same type of data in all ESPON countries would significantly reduce the data gaps identified in our study. Some of the main differences identified during our research are: (1) the reported time of occurrence and the spatial extent of a disaster; (2) the classification of the type of a disaster and the definitions of their indicators; (3) currencies and prices of economic losses. This is also strongly recommended by Poljanšek et al. (2021) in the NRA report on DRM. Although the Risk Data Hub of JRC covers a large range of hazards, loss and risk data comparability is still an issue to make the information useful for disaster risk assessment. Thus, harmonisation (or even standardisation) of loss data gathering is needed (collection of disaggregated loss data in loss and damage databases) and helps to empirically identify the physical vulnerabilities of different assets under different hazards (Poljanšek et al. 2021: 30-31).

Explanations:

Description of policy recommendation

This policy recommendation contributes to answering the question what could be done to improve data availability on economic losses associated with disasters and natural hazards, especially at local and regional levels across Member States/authorities.

In contrast to the previous policy recommendation this one aims at the collection of the necessary data at the local level across Member States/authorities in order increase the comparability of results and thus complements policy recommendation A-1. This also includes standardised data collection at the local level in the aftermath of a disaster and allows the inclusion of tacit local knowledge. While damage data describe the strength and patterns of impacts of disasters, the data on exposure and vulnerability describe the reason for the impacts. These data are regarded to be important because these are risk components where management measures can be put to action (T.-E. Antofie, JRC, 14 October 2020). The Risk Data Hub developed by JRC aims to support the effectiveness and efficiency Disaster Risk Management (DRM) by providing access to and sharing of EU-wide curated risk data (Antofie et al., 2019; 2020), including specific data on losses (Faiella et al., 2020).

Data collection should include local authorities because they can play a very important role in this as they are in place to know better than anyone else the local context. A better use of local and tacit knowledge could thus help to close knowledge gap and make available data more useable and actionable at the local level. However, giving this responsibility to the local authorities will lead to unharmonised collected data and may lead to less granular data (see policy recommendation no. B-2). To address this limitation, and taking into account what was suggested above, authorities at higher levels (e.g. ESPON) could develop a framework for the collection of the necessary data in order to harmonise the collection across Member States/authorities, which can then be used by the local authorities for the measurement and data collection.

Specific Action

As a specific action we recommend that the European Commission discusses and evaluates different approaches for developing such a framework. As a specific action we recommend that the European Commission discusses and evaluates different approaches for developing a framework to increase data collection and availability. In order to better follow up and to collect the information hand in hand with the affected regions (an a national focal point?) we recommend a coordinated approach; some alternatives are possible: Firstly, and in connection with policy recommendation A-1, the existing Risk Data Hub (EC, DG ECHO, JRC) could be further developed by motivating Member States to contribute with comparable data. Secondly, EUROSTAT could extend their data entry forms regarding the collection of hazard, risk and damage data down towards the LAU level (previously

NUTS 4 and NUTS 5 levels). Thirdly, the INSPIRE Directive could be amended regarding Annex III, by renaming theme 12 “Natural risk zones” to “Zones of natural hazards and past economic damages” and thus taking care of providing this additional geospatial data. For data provision, the EC should further foster cooperation with insurance and reinsurance companies. Thus, this policy recommendation contributes to the stage of implementation within the policy process.

Target and territorial level of policy recommendation

EU (EUROSTAT); data base providers/knowledge institutes (JRC data hub).

Member States, cooperation with insurance companies.

Local and regional authorities: Part of this recommendation is especially relevant for the local level although it might require coordination at higher territorial levels.

Relevance for other policy recommendations

A-1: Harmonisation of concepts and methods for risk assessment and risk evaluation.

B-2: Disaster-related damage data and reporting should be more granular, including the distinction between direct and indirect damages to avoid double counting in economic modelling (especially regarding the granularity of data).

D-1: Focused promotion of a proactive and prevention-oriented design of EU funding instruments in combination with quality objectives regarding funding of reconstruction.

Links and synergies with relevant policies (EU Directives, National policies , etc.)

JRC data hub; EC INSPIRE directive; EUROSTAT; European Commission (2020) Adaptation to Climate Change Blueprint for a new, more ambitious EU strategy.

Link with other ESPON projects (previous or on-going ones)

Alps2050 – Common spatial perspectives for the Alpine area: Eventhough TITAN refers to economic losses associated with natural hazards when recommending the development of a framework for the collection of necessary data, a connection can be seen to the evidence base & and transparency recommendation by Alps 2050. They also have been confronted with obstacles regarding the availability and comparability of data (in terms of territorial development) and stress the importance of changes in the data bases (Chilla et al., 2018).

References

UNISDR (2015) Sendai Framework for Disaster Risk Reduction 2015 – 2030. UNISDR – United Nations International Strategy for Disaster Reduction. UN Office for Disaster Risk Reduction (UNDRR). Geneva, Switzerland.

EC – European Commission (2020) Adaptation to Climate Change Blueprint for a new, more ambitious EU strategy.

Policy recommendation no. B-2

Disaster-related damage data and reporting should be more granular, including the distinction between direct and indirect damages to avoid double counting in economic modelling

Findings from ESPON-TITAN:

Databases do not include sufficient information in relation to hazards (e. g. physical data on the extent and the intensity) (ESPON-TITAN, Tasks 2 and 3).

Explanations:

Description of policy recommendation

Ideally these databases would include more and improved information in relation to hazards. For instance, physical data on the affected area in hectare meters and the intensity of the hazard (e.g. water depth for floods, peak ground acceleration for earthquakes, and SPI data for droughts; detail of damage data especially missing for drought and wind storms). In addition, there is need for more specific spatial information and the vulnerability of certain area (e.g. information on critical network infrastructure such as water, energy, transport and ICT). While it is now too early to wish for such a comprehensive database, several institutions are making progress on the harmonisation of the reporting of hazards, so that in the future research can rely on comprehensive damage and loss data collection (see also policy options for data harmonisation and access in the Ex-ante Impact Assessment of the EU Adaptation Strategy, Trinomics et al., 2020).

Specific Action

To improve the quality and quantity of disaster data, knowledge institutes should better cooperate with each other and Member States. To improve the quality and quantity of data, the European Commission should also consider launching official dialogue/partnership with (re)insurance industry and public authorities to agree first step voluntary recording standard.

Target and territorial level of policy recommendation

EU, Member States, data base providers/knowledge institutes.

Relevance for other policy recommendations

B-1: Development of a framework for the collection of the necessary data at the local level across Member States/authorities (in order to harmonise and streamline and thus increase comparability of results, including harmonised data collection at the local level in the aftermath of a disaster).

Links and synergies with relevant policies (EU Directives, National policies , etc.)

Adaptation to Climate Change – Blueprint for a new, more ambitious EU strategy (<https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12381-EU-Strategy-on-Adaptation-to-Climate-Change/public-consultation>).

Inception impact assessment (<https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12381-Adapting-to-climate-change-EU-strategy>).

Link with other ESPON projects (previous or on-going ones).

References

Trinomics, GWS and IEEP (2020) Study to support an ex-ante Impact Assessment of the EU Adaptation Strategy.

1.2 Policy recommendations regarding the connection between economic losses and appropriate DRM and CCA measures

The second block presents a policy recommendation related to the connection between economic losses and appropriate DRM and CCA measures (section 1.2.1). As a central issue for linking them, a paradigm shift towards a more systemic and holistic view on impacts and the evaluation of risk seems to be indispensable. The inclusion not only of direct but also indirect losses describes this overall principle which is described in the policy recommendation below.

1.2.1 How to link measurement of economic losses due to disasters and natural hazards with the development of appropriate disaster risk management and climate change adaptation measures at different territorial scales

This section relates to the findings from Tasks 2, 3, 4, 5 and 6. Guiding questions:

- How can costs/benefits and the cost-efficiency of measures be judged? (the higher the protection needs are, e. g. for vulnerable regions or critical infrastructures, the higher the costs for DRM and CCA measures could be in order to support EU security, cohesion or the functioning of the single European market)
- Aversion factor for considering indirect losses – how can this be included into CBA of mitigation measures (see the example of Switzerland)?
- How can indirect losses be incorporated into funding mechanisms?
- What does this cost/benefit perspective mean for the judgement of management/adaptation measures (methodology, data; see policy recommendations a) and b))
- What are the implications of the calculation of economic losses for other policy recommendations (e. g. economic loss thresholds as a criterion for granting funds after disasters or for defining keys for distribution of funds among affected countries)?
- How can funding criteria (e. g. for structural development) be extended to natural hazard and climate change related aspects?

- How should measurements of economic losses be financed, who or which institution should carry out these measurements? Would it be possible to define standards for such measurements?

Policy recommendation no. C-1

DRM and CCA measures and plans should always account for the total economic impacts of the occurring natural hazards, including both direct and indirect losses as well as risk aversion factors

Findings from ESPON-TITAN:

In the case study on Prague (local methodology), we have seen the importance of damage functions including both direct and indirect losses. The cost-benefit analysis (CBA) showed the avoided cost for different scenarios and clearly stated the benefit of flood prevention measures (ESPON-TITAN, Task 5).

Explanations:

Description of policy recommendation

This policy recommendation contributes to answering the question how to link the measurement of economic losses due to disasters and natural hazards with the development of appropriate disaster risk management and climate change adaptation measures at different territorial scales.

The selection of a defence measure against a hazard should be made on the basis of the comparison of the cost to implement the defence measure against the damage cost avoided by the prevention of the disaster. Therefore, a holistic investigation of both types of costs occurring by a disaster and projection of the potential total costs if the natural hazard would reoccur in the area in different intensities is key. In the ESPON-TITAN project the case study of Prague (local methodology, see chapter 7) showed the importance of damage functions to predict the damages in certain areas. By using different scenarios presenting different flood intensities, the cost-benefit analysis (CBA) showed the avoided cost per scenario and clearly stated the benefit of flood prevention measures. As such, CBAs can be an important tool to show how DRM and CCA practices can be formulated as structural development making such measures applicable for funding. However, if not only direct but also indirect losses shall be taken into account and if this is the basis for designing DRM measures and CCA plans, these have to be addressed in supra-regional, national or even supra-national plans because of the cross-border character of infrastructure and economic networks, which could be affected by disruptions of infrastructure networks and supply chains. CBAs also can be applied in the systemic criticality context: the higher the protection worthiness of CI is in order to avoid economic impacts on the EU Single Market, the more expensive DRM and CCA measures could be (security, cohesion, functioning of Single Market as criteria/objectives) (see also policy recommendation A-5). In order to further

improve the quality of CBA there is also a need to include those damages in the assessment that are normally neglected due to risk aversion in case of low probability/high damage events. Aversion factors (can be factor 4 in case of 1,000 year annuality) can be used to improve the estimation of indirect losses. Any kind of underestimation of risk and thus of potential losses leads to an increase of the protection gap between insured losses and the losses that finally occur following an event (T.-E. Antofie, JRC, 14 October 2020).

Specific Action

The consideration of indirect losses is already partly done by DG ECHO and some studies (e.g. in the PESETA project; for climate change see Szewczyk et al., 2020) but needs a broader understanding and stronger coordination. As a specific action we recommend that the Commission launches a consultation process on collecting the point of view of institutions, businesses, associations, local authorities etc. to provide their point of view regarding options for a more systemic and holistic view on damage and risk assessment and evaluation. This can be initiated by a Green Paper that discusses the options of implementing this paradigm shift in policies, e.g. as a part of the implementation process of the amended EIA Directive, the future amendment of the SEA Directive or the creation of a European Norm for cost-benefit analyses including indirect and systemic costs and benefits. Thus, this policy recommendation contributes to the stage of problem identification and agenda setting within the policy process.

Target and territorial level of policy recommendation

EC, Member States, EU level and national level research funding institutions, individual research teams, insurance companies.

Relevance for other policy recommendations

A-5: Conceptualisation of criticality as a basis for contributing to the evaluation of risk.

C-3: Conceptualisation of criticality and consideration of critical infrastructures (CI) in the evaluation of risk (systemic risk/criticality perspective).

Links and synergies with relevant policies (EU Directives, National policies , etc.)

EIA Directive, SEA Directive.

Link with other ESPON projects (previous or on-going ones)

References

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Policy recommendation no. C-2

Support a paradigm shift towards a spatially oriented risk assessment and management by including the spatial (cross-sectoral, multi-risk perspective) and temporal (risk dynamics, emerging risks) dimension of risk

(agenda setting component; for methodological component see A-4 recommendation for future research)

Findings from ESPON-TITAN:

Based on the review of NRAs (National Risk Assessments) Poljanšek et al. (2019) conclude that in these assessments the dynamic nature of risk is not well covered, it is not considered how the risk factors change, and how the assessments support DRM planning and finally action. Further, emerging risks are not always identified and generally, the scope of the exercise in time is too short to facilitate prevention and cross-sectorial/trigger events (Interim report, Task 6).

Explanations:

Description of policy recommendation

Spatial dimension of risk: Spatial planning at state, regions or local level is responsible for the development of a particular spatial area (where the sum of hazards and vulnerabilities defines the overall spatial risk) and not for a particular object or threat (e.g. sectoral engineering sciences). Therefore, spatial planning must adopt a multi-hazard approach in order to appropriately deal with risks and hazards in a spatial context, which is inherent whenever natural hazards are addressed. With a multi-hazard perspective, cross-sectoral as well as triggering events come into focus (Greiving et al. 2006).

Temporal dimension of risk: Further, countries, regions and cities are not static but in a permanent change, if not transformation. This dynamic also shapes patterns of risk, including the emergence of new risks, on the one hand by changing hazard patterns (e. g. due to climate change) and on the other hand by changing vulnerabilities (e. g. population growth, migration, infrastructure investments). Scenario-based approaches that take into account uncertainties are needed for risk assessment.

Specific Action

Thus, a paradigm shift towards an inclusion of the spatial and temporal dimensions of risk assessment shall be supported (Greiving et al. 2017).

Target and territorial level of policy recommendation

EU level and national level research funding institutions, individual research teams.

Relevance for other policy recommendations

A-4: Support methodological innovations in risk assessments regarding the spatial and temporal dimension of risk.

Links and synergies with relevant policies (EU Directives, National policies , etc.)

Link with other ESPON projects (previous or on-going ones)

References

Greiving S, Fleischhauer M and Wanczura S (2006) Management of Natural Hazards in Europe: The Role of Spatial Planning in Selected EU Member States. In: Journal of Environmental Planning and Management, Vol. 49, No. 5. pp. 739-757.

Greiving S, Arens S, Becker D, Fleischhauer M and Hurth F (2017) Improving the Assessment of Potential and Actual Impacts of Climate Change and Extreme Events Through a Parallel Modelling of Climatic and Societal Changes at Different Scales. In: Journal of Extreme Events, ISSN 2382-6339, DOI: 10.1142/S2345737618500033, Vol. 4, Iss. 4, S. 1-24.

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Policy recommendation no. C-3

Conceptualisation of criticality and consideration of critical infrastructures (CI) in the evaluation of risk (systemic risk/criticality perspective)

(agenda setting component; for methodological component see A-5 recommendation for future research)

Findings from ESPON-TITAN:

Critical infrastructures can amplify risks within the system (e. g. the whole country) although the physical damage can be restricted to only a very limited area (e. g. highly frequented bridge) – or vice versa: physical damages in remote areas can have considerable negative (economic) effects on own region or town (Interim report, Task 6 as well as Task 5 case study results: interruption of the Dresden main station during the 2002 flooding caused week-long interruption of transportation connections with macro-regional impacts).

Explanations:

Description of policy recommendation

Place-based risk perspective: Any risk management by spatial planning needs to be place-based. Spatial planning authorities are legally responsible to only manage the land-use of their area of responsibility. They can and should take the physical component of CI and, thus, the consequence-based element of criticality into account.

Systemic risk perspective: Cascading effects can be triggered by a hazardous event and can lead to severe impacts outside the area where a hazardous event originally happened. From a spatial planning perspective this means that not only one planning area (e.g., a region or municipality) is concerned but also neighbouring planning authorities.

Thus, there is a spatial mismatch because spatial planning just operates for a specific territory, which often does not capture entire networks. Moreover, planning authorities do not have appropriate information on systemic criticality at hand. Consequently, the systemic focus of criticality runs counter to the areal-oriented view of spatial planning (Greiving et al. 2016; policy recommendations A-3, C-1).

Specific Action

Thus, the evaluation of risk, e. g. when planning large-scale critical infrastructures, requires a consideration of criticality (with consideration of cascading effects) – even outside the exposed area (see also recommendations for future research). Addressing these challenges is a task for national or even EU-wide regulations and in addition to a stronger cooperation between network operators and all regions that are connected by a critical infrastructure network.

Target and territorial level of policy recommendation

EU (DG MOVE, DG ENER but also DG REGIO in regard to cohesion policy), EC, EU level and national level research funding institutions, individual research teams.

Relevance for other policy recommendations

A-3: Research on indirect losses and impacts should increase.

A-5: Conceptualisation of criticality as a basis for contributing to the evaluation of risk.

C-1: DRM and CCA measures and plans should always account for the total economic impacts of the occurring natural hazards, including both direct and indirect losses as well as risk aversion factors.

Links and synergies with relevant policies (EU Directives, National policies , etc.)

The systemic criticality of CI should be addressed for infrastructure-related decisions considering the entire infrastructure network on large-scale territorial levels, such as the European Union (e.g. Trans-European Networks [TEN]) or national levels (e.g. Federal Transport Infrastructure Plan; Bundesverkehrswegeplan [BVWP] in Germany).

The European legal basis for critical (transport and energy) infrastructures is the chapter “Trans-European Networks” in the Treaty on the Functioning of the European Union [Lisbon Treaty] and the Council Directive 2008/114/EC on the protection of European critical infrastructures (disruption or destruction of which would have a significant impact on at least two Member States). EU regulations determine criticality by naming critical network elements as well as “priority corridors” and “projects of common interests” that are necessary for the functioning of the European Single Market.

Link with other ESPON projects (previous or on-going ones)

References

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

Greiving, S.; Fleischhauer, M.; León, C.D.; Schödl, L.; Wachinger, G.; Quintana Miralles, I.K.; Prado Larrain, B. (2021) Participatory Assessment of Multi Risks in Urban Regions—The Case of Critical Infrastructures in Metropolitan Lima. *Sustainability* 2021, 13, 2813. <https://doi.org/10.3390/su13052813>.

1.3 Policy recommendations regarding the improvement of DRM and CCA practices (legislation, funding, cooperation)

The third and last block covers the policy recommendations related to the improvement of DRM and CCA practices in terms of funding, cooperation and legislation (sections 1.3.1, 1.3.2 and 1.3.3). There are several options how they can be improved from an EU and Member State perspective. We distinguish between funding, cooperation and legislative

approaches. In addition to the original two topics that were mentioned here, a third one was added regarding the instruments and policies.

1.3.1 To what extent can different funding mechanisms (European Structural and Investment Funds, Financial Instruments, etc.) be better mobilised to further support disaster risk management and climate change adaptation at territorial level

This section relates mainly to the findings from Tasks 5 and 6. Tentative list (not exhaustive) of questions that could be used to derive policy recommendations:

- Which funding mechanisms have the potential to be extended to support DRM and CCA at which territorial level?
- What are the options to further develop the rather reactive Solidarity Fund to a proactive and prevention-oriented instrument?
- How can funding criteria (e. g. for structural development) be extended to natural hazard and climate change related aspects?
- Funding only granted to certain conditions such as no increase of risk, build back better principle or settlement retreat instead of rebuilding highly vulnerable/exposed structures
- Linkages to upcoming EU national COVID-19 recovery programs?

Policy recommendation no. D-1

Focused promotion of a pro-active and prevention-oriented design of EU funding instruments in combination with quality objectives regarding funding of reconstruction

Findings from ESPON-TITAN:

The ESPON-TITAN findings have shown that several funding instruments for supporting DRM and CCA are available. Although some funding instruments aim at the prevention of natural hazards as well as at climate change adaptation there is still potential to focus more on proactive and prevention-oriented measures. The efficiency of measures could be increased by providing funding only under the condition that certain quality criteria are fulfilled regarding, e. g. reconstruction measures (Chapter 6).

This policy recommendation contributes to answering the question to what extent different funding mechanisms (European Structural and Investment Funds, Financial Instruments, etc.) can be better mobilised to further support disaster risk management and climate change adaptation at territorial level.

Explanations:

Description of policy recommendation

The *Civil Protection Mechanism (CPM)* is to strengthen cooperation in the field of civil protection, with a view to improve prevention, preparedness and response to disasters and assistance can be requested when the scale of an emergency overwhelms the response capabilities of a country. The *EU Solidarity Fund (EUSF)* provides financial assistance to EU countries already facing major natural disasters. After the last amendment the regulations encourage EU countries to develop disaster prevention and risk management strategies by requiring reports before and after applications to the fund. The promotion of adaptation to climate change and risk prevention and management are explicitly addressed in thematic objective 5 of the Common Strategic Framework (CSF), which contains common provisions for the five *European Structural and Investment Funds (ESI Funds)*.

Specific Action

As specific actions we recommend to further develop instruments that can potentially support DRM and CCA. The Civil Protection Mechanism (CPM), the EU Solidarity Fund (EUSF) or the European Structural and Investment Funds (ESI Funds) complement each other well. However, in the event of a natural hazard, a country must activate different instruments/funds to deal with the consequences. It is therefore advisable to make the solidarity fund more proactive or to ensure that the funds are easily linked. This would complement recent trends that can be observed in the NRAs, which show that with growing importance, a long-term prevention-oriented planning perspective complements the short-term reactive perspective (Poljanšek et al., 2021).

Funding can also be linked to CCA action plans, on which DG CLIMA and DG ECHO will work together in the future. The new EU Strategy on Adaptation to Climate Change (EC, 2021) especially understands the financial system as an important element to increase resilience to climate and environmental risks (especially risks and damage arising from natural catastrophes).

Moreover, adaptation action, especially at the regional and local levels, requires sufficient funding. This is why any further funding by EU structural funds should be granted only under the precondition of an existing (local) adaptation strategy in order to assess the climate fitness of the desired European support. In this respect the recently adopted EU Strategy on Adaptation to Climate Change (EC, 2021) makes a large step forward as the Commission will enhance climate proofing guidance, develop an EU-wide climate risk assessment, increase cooperation with standardisation organisations to climate-proof standards and to develop new ones for climate adaptation solutions and support the integration of climate resilience considerations into the criteria applicable to construction and renovation of buildings and critical infrastructure. These considerations, however, should not be restricted to Climate Change Adaptation, but should also incorporate aspects of DRM. For example, funds for reconstruction (especially the EUSF) should be connected to certain conditions/requirements (thresholds, appropriate assessment methodologies, e.g.: inclusion of indirect costs, data provision) in order to guarantee a reconstruction that is better adapted to future hazards and changes otherwise no money will be granted.

Such an approach needs a harmonised/comparable assessment methodology for all countries (see policy recommendations A-1 and B-1) in combination with a monitoring mechanism. It should be evaluated if certain investments (e. g. for maintenance), that indirectly contribute to disaster prevention, can be re-labelled in this context in order to be eligible for being funded under CPM and/or EUSF. This, of course needs clear funding criteria in order to avoid that regular infrastructure maintenance to be re-labelled as disaster risk reduction, which would be an abuse of earmarked funding. Thus, this policy recommendation contributes to the stage of implementation within the policy process.

Target and territorial level of policy recommendation

EC (DG ECHO, DG REGIO)

Relevance for other policy recommendations

A-1: Harmonisation of concepts and methods for risk assessment and risk evaluation.

B-1: Development of a framework for the collection of the necessary data at the local level across Member States/authorities.

Links and synergies with relevant policies (EU Directives, National policies , etc.)

Civil Protection Mechanism (CPM); EU Solidarity Fund (EUSF); European Structural and Investment Funds (ESI Funds).

[Link with other ESPON projects \(previous or on-going ones\)](#)

COMPASS – Comparative Analysis of Territorial Governance and Spatial Planning Systems in Europe: Policy recommendation: Enhance functional areas and territorial cooperation: ESIF regulations and programmes – mainstream territorial cooperation and make it mandatory; Connection to D1: TITAN outlines the extent of funding mechanisms to support DRM and CCA at territorial level and states that funding should only be granted when certain preconditions are fulfilled – the same is the case with the policy recommendations by COMPASS (final report, Nadin et al., 2018).

Financial Instruments and Territorial Cohesion: Policy proposals for the debate on financial instruments (FI) in EU Cohesion policy post-2020 ("There is a need to ensure that administrative requirements are not a disincentive to use FIs rather than grants" and: "Care should be taken to ensure that regulatory requirements do not undermine policy objectives.", Wislade, 2019: 106).

References

1.3.2 How should measures related to disaster risk management and climate change adaptation be coordinated between regions, cities and local governments to ensure their effectiveness? How should regions, cities or local governments cooperate with other regions, cities or local governments in order to increase the efficiency of DRM and CCA measures? What could be a role for different umbrella organisations?

NOTE: This topic was reformulated in order to differentiate more specifically between the terms coordination/cooperation and efficiency/effectivity.

This section relates mainly to the findings from Task 5 (all case studies; Alpine case study with regard to umbrella organisations) and 6. Tentative list (not exhaustive) of questions that could be used to derive policy recommendations:

- Which are the appropriate horizontal and vertical coordination and cooperation mechanisms for different planning and administrative systems?
- How to coordinate actions across border regions?
- Are management plans for biophysical regions (such as river basins, see Floods Directive) an appropriate approach for other hazards / climate impacts?
- How can regional and local levels be supported in terms of data provision, information, methodologies?
- What are the appropriate spatial levels to take action in regard to specific hazards?

Policy recommendation no. E-1

Develop cooperation structures between regions, cities and local governments but also between different experts based on a balanced set of formal and informal elements

Findings from ESPON-TITAN:

The case study analyses in the ESPON-TITAN project 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 openmindedness to share experiences and learn from others (case study interviews Alpine region, J. Papež, A. Schindelegger, K. Heil and Dresden Region, U. Müller, C. Korndörfer, A. Rümpel). As main benefits of cooperations and successful contribution to DRM the interviewees highlighted the possibility to learn from each other, exchange ideas and experiences, learn what can be possible. However, the success of (transnational) cooperation depends very much on the delegates who represent the different national (regional) authorities: are they enthusiastic, practical enough and able to connect with others, do they have the skills and power to support and implement the agreements/initiatives back home?

Explanations:

Description of policy recommendation

This policy recommendation contributes to answering to the following set of questions:

- How should measures related to disaster risk management and climate change adaptation be coordinated between regions, cities and local governments to ensure their effectiveness?
- How should regions, cities or local governments cooperate with other regions, cities or local governments in order to increase the efficiency of DRM and CCA measures?
- What could be a role for different umbrella organisations?

This topic was re-formulated in order to differentiate more specifically between the terms coordination/cooperation and efficiency/effectivity. This section relates mainly to the findings from Chapters 6 and 7 (all case studies, plus Alpine case study, as umbrella organisation), although it also includes findings and recommendations made by other institutions for enhancing the coherence between DRR and CCA in policy and practice (EEA, 2017).

A formal element for a successful cooperation is to provide the cooperation with a political mandate which shows commitment and guarantees resources to organise the cooperation process. In a cooperation contract specific agreements can be fixed, e. g. regarding data provision and exchange which is especially important in any cross-border cooperation.

Finally, a long-term funding definitely contributes to establishing and maintaining cooperation.

However, formal elements have to be supplemented by informal elements such as the personal exchange on working levels, establishing personal contacts and trust (have contact details at hand, learn key phrases in other language in order to communicate more easily in case of an emergency). Another important cooperation element is to bring groups together that have different responsibilities/that have different functions in disaster risk management, especially first responders (civil protection, fire brigades, ...) and prevention oriented (water authorities, spatial planners) actors, so both can learn different perspectives, understand each other's logic.

Thus, this policy recommendation contributes to the stage of implementation within the policy process.

Specific Action

As specific action we recommend that in the field of DRM and CCA formal EU/Community funding of transnational cooperation (Interreg Programme) or cooperation among the Member States themselves should be further supported. Especially the joint work on specific projects where results and data have to be shared on a regular basis help to foster cooperation structures (T.-E. Antofie, JRC, 14 October 2020). However, the findings further suggest to organise cooperation-oriented expert groups that are characterised by a continuity of topics and personnel in order to build knowledge and trust between group members and at the same time have the opportunity to work independently from funding guidelines and reporting requirements. Such expert groups could be installed for a certain transnational or transregional area that is characterised by a specific hazard or risk profile. Experts from public authorities and different territorial levels could cooperate for a medium-term period (e. g. in accordance with the 7-year EU funding periods) in order to establish long-term cooperation structures that last even beyond the funding period.

Target and territorial level of policy recommendation

Transnational organisations, Member States, regions, local authorities.

Relevance for other policy recommendations

Links and synergies with relevant policies (EU Directives, National policies , etc.)

Link with other ESPON projects (previous or on-going ones)

ULYSSES – Using applied research results from ESPON as a yardstick for cross-border spatial development planning. Targeted Analysis 2013/2/10.

References

Feliu E, Tapia Itziar C, Mirari Zaldua V, Jung W, Engelke D, Putlitz A, Brester B, Sylaios G, Gaidajis G, Kokkos N, Castro E, Wolf J, Kaisto V, Chilla T, Jaeger S (2013) ULYSSES - Using applied research results from ESPON as a yardstick for cross-border spatial development planning, Targeted Analysis, 2013/2/10, Final Report, Version 25/01/2013, Luxembourg: ESPON, https://www.espon.eu/sites/default/files/attachments/Ulysses_Final_Report_2013_01_25.pdf.

Policy recommendation no. E-2

Establish a clear coordination structure for DRM and provide it with leadership qualities

Findings from ESPON-TITAN:

In many European countries disaster risk management still is ineffective because coordination and cooperation mechanisms are still weakly developed (from ESPON-TITAN interim report, Task 6; Poljanšek, 2019).

Explanations:

Description of policy recommendation

A robust and flexible governance model in which one authority has the mandate to coordinate all parties involved is essential for an effective DRM. In this respect, leadership skills play a vital role for successful coordination, including long experience, ability to listen and understand and to cooperate, emotional intelligence, language/cultural skills – especially in a transnational context.

Elements, such as contingency plans can help to establish and agree on coordination mechanisms. Such plans are a link between prevention-related DRM and response-related DRM, should be developed for different scenarios (e. g. different flood levels or even scenarios with cascading effects/multi-risk issues), giving different actors the opportunity to train along these scenarios and learn communication paths, need for material, resources, appropriate measures, whom to inform when etc. (interviews Dresden Region, A. Rümpel and Alpine Region, J. Papež).

Specific Action

Establish a clear coordination structure for DRM and provide it with leadership qualities.

Target and territorial level of policy recommendation

Member States, regions, local authorities.

Relevance for other policy recommendations

Links and synergies with relevant policies (EU Directives, National policies , etc.)

Link with other ESPON projects (previous or on-going ones)

PROFECY – Processes, Features and Cycles of Inner Peripheries in Europe: Policy recommendation: Developing strategic capacity (local level): "Case study evidence points to a substantial lack in regional policy coordination, as well as trans-sectoral policy development and gaps in internal and external interactions in most cases. The development of strategic institutional capacity is a decisive factor for breaking downward cycles, changing routines and reversing trends." (Noguera et al., 2017: 48). Slight similarities with E1, as

according to the TITAN policy recommendations a clear coordination structure for DRM is necessary with clear leadership as a decisive factor for success.

References

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, Wood M (2019) Recommendations for National Risk Assessment for Disaster Risk Management in EU, EUR 29557 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-79-98366-5 (online), doi:10.2760/084707 (online), JRC114650.

1.3.3 How to better integrate DRM and CCA into legislative frameworks and instruments of territorial development.

This section relates mainly to the findings from Tasks 5 and 6. Tentative list (not exhaustive) of questions that were used to derive policy recommendations:

- Which European policies, strategies, frameworks, agendas have the potential to be extended to support DRM and CCA at which territorial level? (the need for DRM and CCA is often not reflected in potentially relevant EU documents)
- Change-proof planning/resilience-oriented planning to be mainstreamed in planning and development processes. (including concepts such as settlement retreat, coastal realignment, build back better)
- Further development of the SEA in combination with EIA (incorporation of disaster risks)
- What are the pros and cons of a multi-hazard/risk directive and/or framework directive on climate impact assessment?

Policy recommendation no. F-1

Support DRM and CCA issues during amendmend processes of EU directives

Findings from ESPON-TITAN:

Case study interviews in the ESPON-TITAN project confirmed that EU directives (especially WFD and FRMD) can have a tremendous impact on establishing and implementing certain and especially new issues at all administrative levels. Their implementation helps to support arguments in controversial discussions about the necessity of certain DRM or CCA related actions (case study interview Dresden Region, C. Korndörfer).

Explanations:

Description of policy recommendation

This policy recommendation contributes to answering the question how to better integrate DRM and CCA into legislative frameworks and instruments of territorial development.

The *Floods Directive* (EC 2007) clearly addresses disaster risk management, however, climate change adaptation has not been addressed so far. Nevertheless, from the second cycle of implementation of the Floods Directive onwards (2016–2021), it is mandatory to include the likely impact of climate change in the Preliminary Flood Risk Assessments. For the flood hazard and risk maps, no explicit reference to climate change is made; however, a summary text on the methods used to include climate change in the flood scenarios can be reported as optional information (EEA 2016: 52).

The recent amendment of the *Environmental Impact Assessment Directive (2014/52/EU)* states: “Climate change will continue to cause damage to the environment and compromise economic development. In this regard, it is appropriate to assess the impact of projects on climate (for example greenhouse gas emissions) and their vulnerability to climate change” (EC 2014). Consequently, a so called “evolving baseline trend” (of both climate and society) has to be taken into account when assessing the effects of a project on the environment (EEA 2013).

A similar reference is missing in the Strategic Environmental Directive (EC 2001), although the DG Environment argues for an inclusion of climate change (EC DG Environment 2013). An amendment of the SEA directive that considers the local impact of climate change more explicitly when assessing the effects of a plan or program on the environment appears to be urgently needed. In providing such an amendment, land use policies could be supported that are made in accordance with a given climate change impact profile.

Specific Action

As specific action we recommend is that the Commission, and especially the Directorate Generals, stronger check the potentials to support DRM and CCA and consider these during amendmend processes of EU Directives. Some attention to DRM and CCA has

already been paid in those framework directives which have a territorial dimension. In some cases, DRM and CCA issues were not included from the beginning, but introduced in later amendments of the Directives.

It is clear that the issue of DRM should not be split into several legislations, and of course this complex issue needs an integrated approach (such as provided in EU guidelines for DRM). Thus, it would be good to assess the relevant EU Directives so that they are in line with the EU guidelines for DRM, as long as it is in support of the DRM guidelines. The aim is to have a more integrated approach, but not to make it more complex. Nevertheless, we see the potential that in future amendments of relevant EU Directives specific issues can be tackled that support what could be described good DRM or CCA practice (including support of the DRM guidelines). Examples of such amendments in the past are the amendments of the SEVESO III Directive 2012/18/EU (EU, 2012).

CCA and DRM should thus be integrated in the aforementioned framework directives on water, floods and habitats in order to optimise the fit between the scope of the problem and the scope of decision making. For example, extreme floods are one of the biggest (climate change adaptation) challenges and likely to be the cost drivers for adapting infrastructures. However, both efficiency and effectiveness of fluvial flood risk management depend on a transnationally coordinated river basin management approach in order to avoid passing on negative consequences further downstream (EEA 2016: 7).

Thus, this policy recommendation contributes to the stage of implementation within the policy process.

Target and territorial level of policy recommendation

EC (DG ENV, DG MOVE, DG REGIO)

Relevance for other policy recommendations

Links and synergies with relevant policies (EU Directives, National policies , etc.)

Floods Directive (2007/60/EC), Environmental Impact Assessment Directive (2014/52/EU), Strategic Environmental Directive (2001/42/EC).

Link with other ESPON projects (previous or on-going ones)

References

EC – European Commission (2001) DIRECTIVE 2001/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment.

EC – European Commission (2007) Directive 2007/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the assessment and management of flood risks.

EC – European Commission (2014) Investment for jobs and growth - Promoting development and good governance in EU regions and cities. Sixth report on economic, social and territorial cohesion. Luxembourg: Publications Office of the European Union.

EC, DG Environment (2013) Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment,
<http://ec.europa.eu/environment/eia/pdf/SEA%20Guidance.pdf>.

EEA – European Environmental Agency (2013) Adaptation in Europe - Addressing risks and opportunities from climate change in the context of socio-economic developments. EEA report No. 3/2013, European Environment Agency, Copenhagen, Denmark.

EEA – European Environmental Agency (2016) Flood risks and environmental vulnerability - Exploring the synergies between floodplain restoration, water policies and thematic policies, EEA Report No 1/2016, European Environment Agency, Copenhagen, Denmark.

Policy recommendation no. F-2

Mainstreaming climate change adaption in territorial development policies

Findings from ESPON-TITAN:

There is still potential to include climate change adaptation more systematically in European territorial development policies (ESPON-TITAN, Task 7).

Explanations:

Description of policy recommendation

The Commission adopted the EU Adaptation Strategy in 2013 (EC 2013). It points to mainstreaming climate change adaptation into EU policies, but does not mention territorial development or territorial cohesion as relevant policy fields for fostering adaptation. At the national level, most of the 21 existing adaptation strategies refer not only to the various affected sectors such as agriculture, water, human health and the environment (as the most commonly mentioned sectors), but also to territorial development in general and spatial planning in particular (EEA 2014; Greiving & Fleischhauer 2012).

Very little attention is spent on adaptation in the Europe 2020 Strategy, which states: “We must also strengthen our economies, resilience to climate risks, and our capacity for disaster prevention and response”, but does not recognise the importance of socio-economic factors for adaptation (EC 2010: 13).

The European Commission’s Sixth Cohesion Report discusses climate change developments in Europe within its chapter on sustainable growth and acknowledges the importance of socio-economic factors. A particular focus is made on the need for the EU to adapt to more frequent and disastrous natural hazards. A complete section maintains this focus and concludes that “policies for preventing and managing risk are essential to ensure that development, and economic growth, are sustainable” (EC 2014: 108).

The renewed Territorial Agenda 2030 will set out to ensure that the need for a sustainable future for all places and people is addressed appropriately, and that the territorial dimension and the diverse potential of places across Europe are taken on board by all relevant policies. The draft Territorial Agenda 2030 outlines two overarching objectives, a Just Europe and a Green Europe, broken down into six priorities for the development of the European territory of which one explicitly addresses climate change: “The impacts of climate change vary considerably across European geographical regions with different impacts and degrees of vulnerability. The increased risks of sea-level rise, heat waves, drought, desertification and other land and soil degradation, floods and other natural hazards call for place-based responses, cooperation and coordination of policies. [...] Climate change impacts as well as mitigation and adaptation actions depend on the territorial context and require tailor-made responses at all levels.” So far, the draft Territorial

Agenda does not address the cross-border and large scale (economic) impacts that a disruption or destruction of critical infrastructures – as a result of disasters – can cause.

Specific Action

In principle, adaptation to climate change is a cross-cutting issue that needs to be mainstreamed at all spatial levels because of the variety of impacts on different sectors and the interdependences between impacts and cross-sectoral response strategies. This should be prominently addressed and outlined throughout territorial development policies and should bear in mind the importance of context specificity in the ability to implement adaptation strategies.

Target and territorial level of policy recommendation

EC (DG ENV, DG MOVE, DG REGIO).

Relevance for other policy recommendations

A-1: Harmonisation of concepts and methods for risk assessment and risk evaluation.

Links and synergies with relevant policies (EU Directives, National policies , etc.)

EUROPE 2020 – A strategy for smart, sustainable and inclusive growth; EU Strategy on adaptation to climate change; Sixth report on economic, social and territorial cohesion.

Link with other ESPON projects (previous or on-going ones)

References

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2 Methodological and data related recommendations (recommendations for future research)

The following research recommendations were developed in parallel to the policy recommendations (see Chapter 1 and Table 1.2). As they cover methodological issues, they are discussed in this section on future research needs.

Most of the presented recommendations are related to methodologies and based on the research performed in ESPON-TITAN, that includes some shortcomings and challenges that need to be addressed (recommendations A-2 to A-7). Apart from the ESPON-TITAN own findings, there are also research efforts from other institutions that address either CCA or DRM or both.

Although not explicitly focused on future research, recommendation A-6 was included in order to strengthen efforts of actors on the different territorial levels to strategically use research funding as a tool to support DRM and CCA practice.

Policy recommendation no. A-2

Further development of appropriate damage functions for different types of hazards including the calculation of uncertainty parameters

Findings from ESPON-TITAN:

Currently, there are no widely available damage functions for other hazards than floods and, to a certain extent, earthquakes. Even though the damage function for flood is well developed and covers all the European countries, there is still room for improvement (ESPON-TITAN, Task 3).

Explanations:

Description of recommendation for future research

The improvement of damage functions for floods is mostly related to data input (to make it as event specific as possible) and to better illustrate the uncertainties of these damage functions. For instance, the damage functions used in the ESPON-TITAN study apply to all the countries in Europe. This leads to uncertainty and inconsistency of results, as the damage functions in practice differ per country. Moreover, the damage functions are developed for urban environments as the underlying data on maximum damages is derived from construction cost surveys, which mainly concern costs of urban types of buildings (Huizinga et al., 2017). For the maximum damage value, it is also important to note there is a difference between urban and rural house prices. In general, house prices are more expensive in urban areas assuming houses are the same size (Huizinga et al., 2017). The uncertainties mentioned above are not exhaustive as many other uncertainties derive from using global damage functions. As such, there is a need to collect more country and

regional data to improve the data applied in the damage functions. For future reference, uncertainty parameters should be calculated to show the level of uncertainty when using damage functions.

For hazards apart from river floods, ESPON-TITAN used a more bottom-up approach to distribute the damages among sectors for each event. However, this approach was only possible as there were not many events recorded for these hazards. To improve the methodologies that distribute economic damages among sectors, there is need for further research into damage functions for earthquakes, droughts, and winter storms.

Target of recommendation for future research:

EU level (JRC might develop damage functions with national resolution) and national level research funding institutions for providing support for research teams, however, it can be assumed that the development of damage functions most likely is a task for academia/individual research teams.

Relevance for policy recommendations

References

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Policy recommendation no. A-3

Research on indirect losses and impacts should increase

Findings from ESPON-TITAN:

The Impact Pathways revealed a wide variety of indirect impacts of the four natural hazards, which due to methodological and budget constraints were not quantified in our approach (ESPON-TITAN, Task 3).

Explanations:

Description of recommendation for future research

Our research showed that the indirect losses can be as high as the direct losses, and this refers only to a very narrow range of types of indirect impacts. Given that different natural hazards give rise to different indirect impacts, there are ample opportunities to explore indirect losses and thus increase the accuracy of the estimation of total economic losses of disasters and natural hazards. Methodologically it should be discussed if indirect losses due to economic triggering (supply chains) shall be distinguished from indirect losses due to economic impacts because of triggering of natural hazards (or even natech hazards) – there might be an added value, however it seems difficult to disentangle the effects.

Target of recommendation for future research

EU level and national level research funding institutions, individual research teams.

Relevance for research/policy recommendations

A-5: Conceptualisation of criticality as a basis for contributing to the evaluation of risk.

C-3: Conceptualisation of criticality and consideration of critical infrastructures (CI) in the evaluation of risk (systemic risk/criticality perspective).

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Policy recommendation no. A-4

Support methodological innovations in risk assessments regarding the spatial and temporal dimension of risk

Findings from ESPON-TITAN:

Project findings indicate that real integrated multi-risk assessment methodologies as well as dynamic changes in risk settings are still hardly developed. Even recent and advanced studies, that explicitly develop a multi-hazard approach, including the temporal change in hazard patterns and the impacts on critical infrastructures, still have to accept limiting assumptions: independent hazards (without accounting explicitly for hazard interrelations), no estimation of probabilities of coincidental or cascading events and static vulnerability (Forzieri et al, 2015: 37; 126; 2016; 2018). Although challenging, dynamic changes and interactions should sooner or later be integrated into risk assessment approaches.

Explanations:

Description of recommendation for future research

Spatial planning must adopt a multi-hazard approach in order to appropriately deal with risks and hazards in a spatial context, which is inherent whenever natural hazards are addressed. With a multi-hazard perspective, cross-sectoral as well as triggering events come into focus. Some European regions, such as Lombardy based on previous disaster experiences, have already established hazard assessments that cover several natural hazards in a multi-scale approach (A. May, Lombardy Region, Italy, 14 October 2020). Further, countries, regions and cities are not static but in a permanent change, if not transformation, and scenario-based approaches that take into account uncertainties are needed for risk assessment. Thus, methodological innovations are needed in order to take into account the spatial and temporal dimensions of risk.

Target of recommendation for future research

EU level and national level research funding institutions, individual research teams.

Relevance for policy recommendations

C-2: Support a paradigm shift towards a spatially oriented risk assessment and management by including the spatial (cross-sectoral, multi-risk perspective) and temporal (risk dynamics, emerging risks) dimension of risk.

References

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Policy recommendation no. A-5

Conceptualisation of criticality and consideration of critical infrastructures (CI) in the evaluation of risk

Findings from ESPON-TITAN:

Critical infrastructures can amplify risks within the system (e. g. the whole country) although the physical damage can be restricted to only a very limited area (e. g. highly frequented bridge) – or vice versa: physical damages in remote areas can have considerable negative (economic) effects on own region or town (Interim report, Task 6 as well as Task 5 case study results: interruption of the Dresden main station during the 2002 flooding caused week-long interruption of transportation connections with macro-regional impacts).

Since the adoption of the Council Directive 2008/114/EC, the EU provides a framework for identifying critical infrastructures at national and EU levels. The topic of critical infrastructure disruptions is also addressed in detail with regard to concepts, availability of data and assessment and management approaches in the report "Recommendations for National Risk Assessment for Disaster Risk Management in EU" (Poljanšek et al., 2021). Also, the report "Science for Disaster Risk Management 2020" acknowledges the important role that the research on critical infrastructures plays for improving DRM. The report describes and discusses criticality and cascading effects due to infrastructure failures and also points on management priorities how to protect critical infrastructures and how to deal with consequences of such failures (see also OECD, 2019). However, the report further calls for a comprehensive risk assessment that should combine the multiple regulations and activities regarding critical infrastructures (Casajus Valles et al., 2021). Such risk assessment that includes the criticality of infrastructures would embrace a combined contingency and systems approach, which could help "to identify hazards, vulnerabilities and threats, update the list of critical infrastructures and essential services, determine interdependencies and ultimately define capability targets" (Casajus Valles et al., 2021). This demand, together with the own findings shows that methodologies for criticality assessments of infrastructures are still at the beginning. Development, validation and usability for implementation of policies for infrastructure development and preventive DRM shall be further supported.

Explanations:

Description of recommendation for future research

Place-based risk perspective: Any risk management by spatial planning needs to be place-based. Spatial planning authorities are legally responsible to only manage the land use of their area of responsibility. They can and should take the physical component of CI and, thus, the consequence-based element of criticality into account.

Systemic risk perspective: Cascading effects, however, may take place outside the defined planning area (e.g., a region or municipality) while spatial planning just operates for a specific territory, which often does not capture entire networks. Moreover, planning authorities do not have appropriate information on systemic criticality at hand. Consequently, the systemic focus of criticality runs counter to the areal-oriented view of spatial planning (Greiving et al. 2016; policy recommendations A-3, C-1).

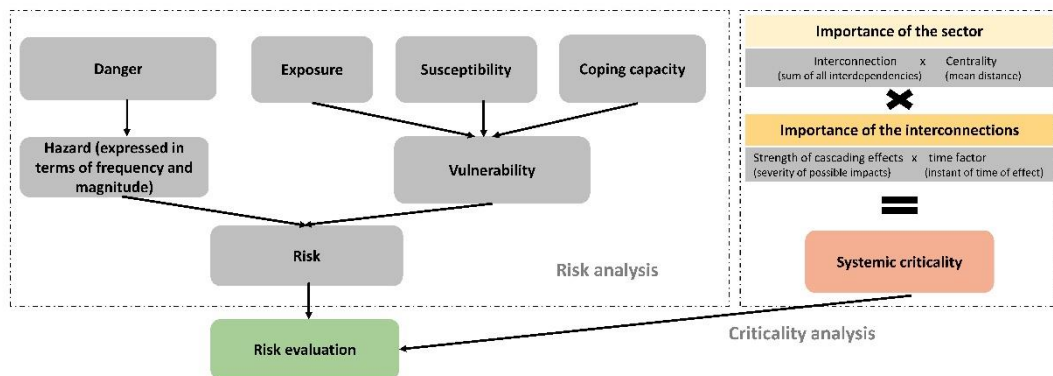
The systemic criticality of CI should be addressed for infrastructure-related decisions considering the entire infrastructure network on large-scale territorial levels, such as the European Union (e.g. Trans-European Networks [TEN]) or national levels (e.g. Federal Transport Infrastructure Plan; Bundesverkehrswegeplan [BVWP] in Germany).

The European legal basis for critical (transport and energy) infrastructures is the chapter “Trans-European Networks” in the Treaty on the Functioning of the European Union [Lisbon Treaty] and the Council Directive 2008/114/EC on the protection of European critical infrastructures (disruption or destruction of which would have a significant impact on at least two Member States). EU regulations determine criticality by naming critical network elements as well as “priority corridors” and “projects of common interests” that are necessary for the functioning of the European Single Market.

To further operationalise the spatial dimension of systemic criticality, a normative judgement is required to determine the worthiness of protection of specific network elements as in the case of the European Council’s regulations. This judgement should ideally consider the result of a sectoral criticality assessment, which could in principle be performed on various spatial levels depending on the extent of the respective infrastructure system (good practice example: federal spatial plan for a nationwide spatial flood protection (Bundesraumordnungsplan Hochwasserschutz [BRPH]) (BMI and BBSR, 2020).

Thus, multi-risk assessment is not just a multi-hazard assessment, but requires a consideration of cascading effects – even outside the exposed area (see figure below).

Figure 2.1 Criticality analysis as part of the risk evaluation framework.



Source: Greiving et al., 2021

Target of recommendation for future research

EU (DG MOVE, DG ENER but also DG REGIO in regard to cohesion policy), EC, EU level and national level research funding institutions, individual research teams.

Relevance for policy/research recommendations

A-3: Research on indirect losses and impacts should increase.

C-1: DRM and CCA measures and plans should always account for the total economic impacts of the occurring natural hazards, including both direct and indirect losses as well as risk aversion factors.

C-3: Conceptualisation of criticality and consideration of critical infrastructures (CI) in the evaluation of risk (systemic risk/criticality perspective).

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Policy recommendation no. A-6

Support regions and the local level in using research and cooperation projects more strategically for DRM and CCA

Findings from ESPON-TITAN:

In the ESPON-TITAN case study analyses some observations were made regarding the function that research and cooperation projects can have for introducing new topics, testing new methods and binding stakeholders to certain DRM and CCA related topics and objectives. However, the application process is full of prerequisites and implementation often sputters after the project funding period (case study interviews Dresden Region, P. Seifert, U. Müller, C. Korndörfer).

Explanations:

Description of recommendation for future research

The European territorial cooperation (ETC), also known as *Interreg*, is an obviously relevant funding scheme. It provides a framework for joint action between Member States and promotes transboundary cooperation. The relevance of territorial cooperation for adaptation is evident due to the cross-border character of many impacts of climate change and is therefore a joint responsibility, which calls for strong coordination and cooperation. Climate change-related actions encompass already a large share of the Interreg programmes' allocations (Interact, 2019) with a spatial focus on those regions in Europe that were identified as being particularly vulnerable (such as South-eastern Europe or mountain regions). Also research projects under the *Horizon 2020* programme or under national research programmes have shown that they can raise attention and activate regional and local stakeholders and the public. However, after the end of the project, further activities are often not continued.

Nevertheless, regions and local authorities can use research and/or cooperation projects strategically for DRM and CCA as they fulfil different functions: (1) commit policy makers/decision, makers/planners to certain topics that were only in the background before; (2) acquire additional financial/personnel resources and thus be able to tackle challenges in a way that was not possible before; (3) bind personnel/project group across departments/sectors, support intracommunal communication.

Thus it is also recommended to provide especially research projects with follow-up implementation phase (better: permanent positions that further support DRM and/or CCA) in order to transfer the results/findings into practice.

Target of recommendation for future research:

EC (DG REGIO, DG RTD), Member States, regional and local authorities.

Relevance for policy recommendations

References

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Policy recommendation no. A-7

Research on how to consider human losses as additional impact of natural hazards, on their inclusion in decision-making processes

Findings from ESPON-TITAN:

Considering the project's scope, loss of human lives was not included in the assessment methodologies (Chapter 4), making the focus exclusively on economic-related assessment. It is very likely that the inclusion of human losses in the assessment methodologies would have led to different distribution of economic impacts of natural hazards.

Explanations:

Description of recommendation for future research

Although this issue was not studied in depth, we are aware that the (potential) losses to human lives are often under-estimated because of ethical and methodological reasons, and that it is a challenge to be represented in economic terms. Given the interest shown on these terms, we recommend broadening research to consider human losses as additional impact of natural hazards, as well as to further discuss how this issue can be considered in decision-making processes.

Target of recommendation for future research:

EU level and national level research funding institutions, individual research teams.

Relevance for policy recommendations

References

3 Lessons learnt from regional and local case studies

The policy recommendations generated from ESPON-TITAN scientific findings, included in the previous sections, are focused mainly on EU specific actions. As mentioned, the set of recommendations presented is centred on topics that cover the different stages of the policy process, as well as methodological issues. These same topics were covered on the analysis of the eight ESPON-TITAN case studies (Annex 5), of which some lessons learnt were extracted, based on practical experiences of regional and local stakeholders, that were, in most of the cases, technicians, policy- and decision-makers.

The investigation of these case studies was based on going through an exhaustive analysis of, not only the natural hazards that mainly affect each region and their economic impacts, but mainly on the DRM and CCA instruments in place in terms of legal framework, assessment and management. Special attention was put into their integration of these practices into spatial and sectoral planning, including cooperation and coordination dynamics.

From the analysis, some lessons learnt were identified in relation to the good practices on integrating DRM and CCA into spatial planning. Given that the selected case studies are representative from different regions across Europe, those lessons learnt may constitute a good reference for other regional and local administration. The following conclusions and lessons learnt were reached from the case studies analysis:

Territories should focus more on risk prevention activities rather than response/reaction, as it has a relevant cost but is worth it. Nowadays, even if climate change causes more intense events, and anthropic pressure becomes harder, there are fewer damages as a consequence of an event than in the past, as shown in Prague, Andalusia, Po river Basin, City of Pori and Rotterdam. The Dresden Region and Rotterdam show that authorities should focus on long-term decisions as, because of climate change, the conditions might get worse faster than anticipation and decisions are made, in terms of preventive measures.

Risk cannot be avoided nor reduced to zero, but they can be managed. Thus, residual risk should be accepted and managed through a sound preparation and disaster management measures. In this line, it is significant to create an effective alert and rescue system, as seen on the Dresden Region. Moreover, compensation systems to mitigate the effects after an event are crucial, as seen on the Andalusia case. In the context of emergency management, the importance of the human factor has been highlighted in the Po river Basin.

Mitigation and prevention are processes that include a whole toolbox of measures. In these lines, funds for constant maintenance are needed, and the responsible institutions must be clearly identified, as seen on the City of Pori, Po river Basin and Nouvelle-Aquitaine.

New methodologies must be implemented for risk assessment, providing maps and systems of observation, evaluation and scenarios (as in Nouvelle-Aquitaine), not only in the long, but also in the middle and short-term, also counting on public participation and

education (as in Rotterdam). For instance, flood prevention areas should be designated based on hazard intensity, considering parameters like flow speed and water depth instead of the probability of occurrence, as seen on the Dresden Region. Moreover, the use of return period (historical information) must be completed with methodologies based on scenarios, as seen on the City of Pori, Po river Basin and the Dresden region.

The case studies showed the **importance of binding laws regulating every aspect of DRM**. The Cities of Pori and Rotterdam highlight the importance of including prevention measures, maintenance periods or update frequency in the law. The first is a good example of legal obligation, linking risk assessment to spatial planning. The local level is decisive for a successful DRM strategy, as every administration level must be aware of risks and allocate the necessary resources to manage them, as seen on the Alpine Region, Andalusia and the Po river Basin. But the legal binding character is not enough, as it should be complemented with support from other (also informal) administrative instruments. Thus, the regional and national level should offer the local level financial support, guidelines and knowledge, as shown in the Po river Basin. However, a generalized criticism is that local authorities should prioritize risk assessment and management, as in the City of Pori and Rotterdam for instance.

Prevention is based on this knowledge, applied to the determination of urban and buildable areas. **Municipal planning must consider risks much more than they do nowadays, because it is the key instrument which regulates land-use**. Authorities should pay special attention to areas where buildings have been installed without much consideration or outdated methods concerning risk management in the past, as seen on the City of Pori, Po river Basin or Nouvelle-Aquitaine. Possible solutions are gradual delocalization, insurance, or urban rehabilitation. In this line, it must be highlighted that the support of urban rehabilitation, along with the “2050 zero land-take” objective of the EU, must consider the climate change impacts and its associated risks, redesigning cities and territories in this direction. Urban planning irregularities were revealed, and are associated with high costs. To protect people's lives and incur the lowest costs, the most effective alternative is to avoid the urbanization of high-risk areas, whose maintenance and future safety can only be ensured if responsibility for them lies with clearly identified officials.

A top-down approach is still predominantly followed, although **vertical coordination and cooperation are very important for DRM and CCA**. Some good examples are the common geographic information platform of the Po river Basin, the role of Civil Protection in Andalusia or the interactive and online tools for DRM enhancing cooperation between the different administrative levels and the inclusion of citizens in the Dresden Region. Concerning CCA, adaptation strategies and action plans developed at the national and regional level should be transferred to the local level through adaptation measures.

Intersectoral coordination should be improved in all areas of risk management, as well as in the management of adaptation to climate change. In this context, policies for risk

management and CCA cannot remain sectoral, but should be integrated with spatial planning and development programs as seen with several paths on the Dresden Region, in Nouvelle-Aquitaine and in the Netherlands. In the future, cross-sectoral measures should be better integrated with, and promoted, as part of adaptation measures. A good example of vertical coordination is Rotterdam, in which the national government produces and communicates knowledge, generates policy at this level, and exercises leadership over other governments; and at the local level the spatial planning is mostly developed. The examples from Rotterdam¹ show the need/possibility of rethinking land-uses under areas where flooding is foreseen to suffer changes resulting from climate change.

A sound strategy for DRM and CCA should involve all the relevant actors of the territory, as seen on the Dresden Region, City of Pori, Rotterdam and Po river basin. This cooperation and collaboration benefits from their innovation capacity, as professionals, universities, and enterprises are constantly developing new solutions and new skills, as seen on the Dresden Region and Po river basin.

Natural phenomena do not care about administrative borders, so cooperation between regions must be put in place. This cooperation must exist between regions within a country, as seen on the Po river basin, but also between countries, as seen on the Alpine Region and the Dresden Region. Cross border cooperation is key for transnational spatial planning, DRM and CCA. In this line, the Alpine Region showed the importance of transnational programmes, such as EUSALP, and transnational projects like GreenRisk4Alps.

The supranational level should set common standards for DRM and CCA strategies within the European Union. The success of the Flood Risk Management Directive 2007/60/EC is a good example of what can be done in the European institutions.

The case studies analysed showed that **in the long-term, sustainable and effective cooperation must be built on formal agreements, but it can only be filled with the human component.** Thus, personal connections, mutual trust and open-mindedness to share experiences and learn from each other is a key factor. In this line, the URBACT and INTERACT programs are good examples of how the European Union can foster this kind of exchanges. By keeping clear subsidiarity and proportionality principles, European dimension is necessary as a common house of benchmarking to help driving common improvements in these fields; by learning from the best practices, but also with decided leadership from Directives for First Pillar

¹ Semi-detached dams to provide collective public space and defending against floods; recreational waterways serving a similar purpose. Spaces that store water, floating adaptable buildings, water squares for collective use, and the blue roofs (Kruisplein and in Museum Park), rowing lane as water retention area near Zevenhuizenplas; the floating forest and floating pavillion near Wilhelminapier, the floating Park in Rijnhaven (not yet built), the water storage in Museumpark parking garage, the Vierhavenstraat multifunctional flood defence with park and shopping mall, and water squares like Benthem water square (Rotterdam Climate Initiative, 2014; Braw, 2013).

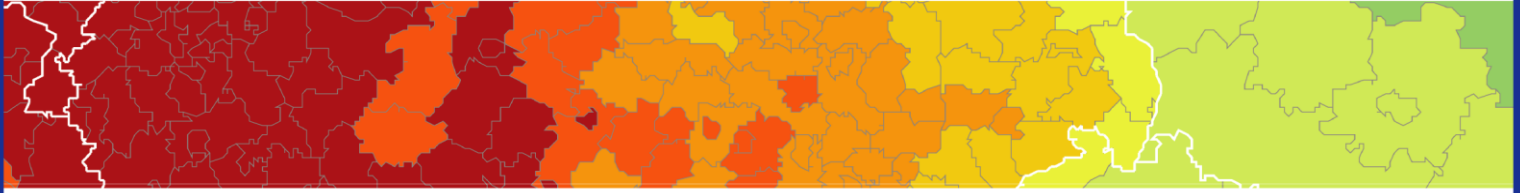
Policies and those in which territorial cross-border cooperation demonstrate specially potential and usefulness, as it is the case of DRM and CCA.

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