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ORIGINAL PAPER

Disaster risk management, climate change adaptation and the role of spatial and urban planning: evidence from European case studies

Joaquín Farinós-Dasí[1] · Pablo Pinazo-Dallenbach[2] · Enrique Peiró Sánchez-Manjavacas[3] · Diana Catalina Rodríguez-Bernal[3]

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Abstract

This paper advances knowledge and understanding of the relationships between risk management, climate change adaptation and spatial planning as good territorial governance practices. The aim is to present evidence on how risks and their management are progressively being integrated into national planning systems in order to reduce territorial vulnerability and costs related to natural events in the European context. This paper is based on the ESPON-TITAN project which focuses mainly on flood events that occurred in Rotterdam, Prague, the Po river basin, Pori, Andalucia, Nouvelle-Aquitaine, Dresden and the Alpine region. The paper reviews the literature and planning instruments applied in the selected case studies, as well as interviews with key stakeholders and decision makers. The results confirm the hypothesis that traditional disaster management is evolving towards Disaster Risk Management, clearly recognizing that Climate Change modifies and increases threats. Data on the consequences of natural disasters support the desirability of a proactive rather than a reactive approach, highlighting the crucial role of planning. The resulting governance is more "functional" than "territorial", leaving room for further advances and innovations such as territorial and multi-risk perspective, partnerships and civil society participation, and soft versus traditional hard or engineering solutions.

Keywords Spatial planning · Natural hazards · Climate change · Adaptation · Economic impact · Disaster risk management

✉ Joaquín Farinós-Dasí
Joaquin.Farinos@uv.es

1 IIDL and Geography Department, University of Valencia, Valencia, Spain

2 Department of Engineering Projects, Universitat Politècnica de València, Valencia, Spain

3 GDLS, IIDL, University of Valencia, Valencia, Spain

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1 Introduction

This article advances the knowledge and understanding of the relationships between risk management, climate change adaptation and spatial planning as good territorial governance practices that aim to prevent and reduce the social, economic and environmental consequences caused by natural hazards. The aim is to find evidence on how risks and their management are progressively included in national planning systems in the European context to reduce territorial vulnerability and costs. To that end, there is a combination of methods: first, an analytical review of the specialized literature on this topic and a documentary analysis of applied planning instruments in selected case studies (CSs). Second, interviews with key stakeholders and decision-makers related to the CSs were conducted to identify documents and policies applied and to verify the content from a practical perspective. Through them, we can determine how the territorial approach (spatial planning) and the management of natural risks are approached and integrated to achieve better adaptation to the effects of climate change and global warming.

The article contains five sections following this introduction. Based on the scientific literature and related documents, the second section theoretically delves into the risk-nature-planning relationships. The third section presents the starting hypotheses in the international context regarding hazards, the research questions and the methodology used. In other words, this section shows how to conceive and apply spatial planning in terms of risk management related to climate change through hypothesis testing and research questions with real situations reflected in the selected CS's. The fourth section presents the results obtained from the individual case studies and their geographical context to analyse all of them together (through a SWOT analysis) to verify to what extent the hypotheses based on the theoretical dimension are supported or must be rejected. These results are treated and discussed in the fifth section, which is the discussion section, using CAME analysis as the framework. The final section of the paper contains the conclusions and recommendations.

The results from the case studies confirm the hypothesis that the general trend is an evolution from traditional disaster management to disaster risk management (DRM), clearly recognizing that climate change (CC) modifies and exacerbates threats. Data on the consequences of natural disasters support the suitability of proactivity instead of reaction. Planning contributes to proactivity as the preferred field for governance, that is, the coordinated action of the different public administrations responsible for public policies and the integration of sectoral approaches related to DRM and CC based on public participation processes. While a top-down/hierarchical approach predominates in risk management, planning tends to be more heterarchical. However, despite the persistence of traditional tools (hierarchical, sectoral, ex post), there is a move towards new governance practices on risk management, depending on planning traditions. This governance is more 'functional' than 'territorial', leaving room for further advances and innovations: territorial and multi-risk perspectives, partnerships and civil society involvement, and more soft solutions than traditional hard or engineering solutions (in general, more useful ex ante).

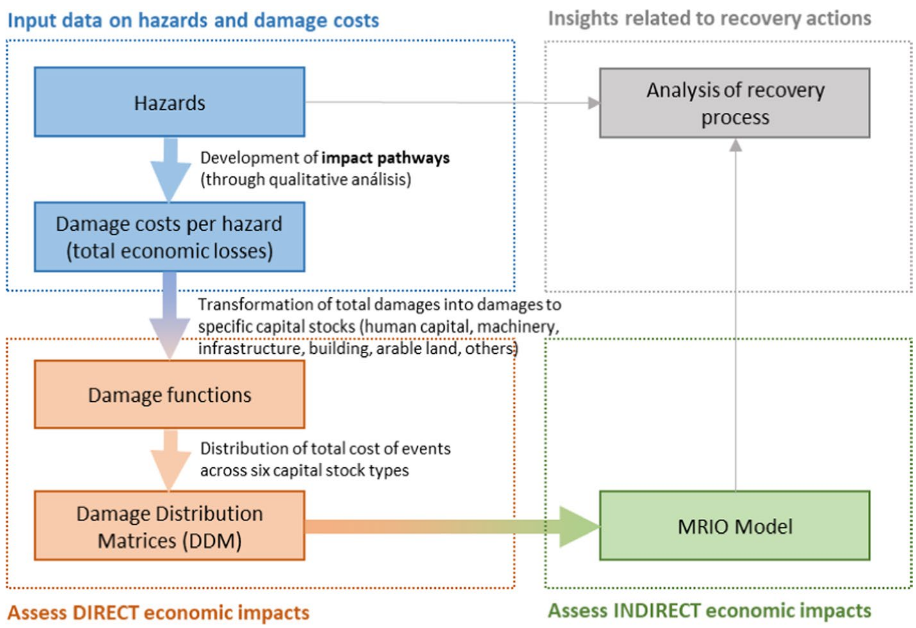

Fig. 1 Data related to hazards and damage cost considered. *Source* ESPON TITAN PROJECT final report

2 The relationships between risk, nature and planning

The ecological dimension currently represents a new consideration. Nature and social systems have the same value due to the interdependence between them (Colding and Barthel 2019), requiring an interdisciplinary dialogue (Urquiza and Cadenas 2015) that finds spatial planning (in its triple dimension of public policy, scientific discipline and administrative technique; CEMAT 1983) a suitable field for development. However, as we confirm in this paper, there is room for improvement. The relationship between social and ecological systems is still controversial due to the lack of effective spatial planning as an integrated tool (Armonia Project 2006; Fleischhauer et al. 2007).

Planning could operate ex ante as a space for mediation between both systems (social and ecological) by influencing the variables that motivate the conflict (Natenzon 1995). Planning offers a territorial diagnosis of the physical space, population and activities and decides which alternatives will guide public policies. However, planning has been operating mainly ex post, from an anthropic interest and point of view, as a tool for managing the impacts of natural phenomena, measured and specified in monetary terms. This economic dimension includes direct costs, usually quantified (e.g., direct damage to physical infrastructure), and indirect damage and recovery costs that may go unnoticed or be not included (e.g., the loss of productivity and competitiveness, time and income situation), causing an increase in the total cost of disasters (Mendoza and Méndez 2018). Von Dahlen and Von Peter (2012) propose a linear correlation between the frequency of natural disasters and their economic impact. Due to the increase in events considered hazards caused by the increase in socioeconomic exposure, the costs increase. For this reason, to obtain information about economic impacts derived from risk, we consider direct (direct damage to capital stock) as well as indirect (disruption of economic activities in other linked regions) costs (see Fig. 1).

As noted by the EU Environmental Committee (EUEC) (2006), rising temperatures have effects on droughts (affecting agriculture) and more intense storms (increasing floods). However, this should not make us lose sight of the fact that climate change is also associated with other threats with much greater potential impacts (such as sea level rise or changes in oceanic thermodynamics). Based on the findings of Anderson and Bausch (2006), the EUEC collected evidence on the impact of natural risks. In 1999, a series of storms caused almost 150 deaths and insurance costs of 6.7 billion euros because of Cyclone Lothar and losses of 500 million euros due to Cyclone Anatol. In 2002, a flood related to the Danube and the Elbe happened in European territory. It affected 600,000 people and caused 80 deaths and economic losses of 15 billion euros. In the summer of 2003, Europe suffered a heat wave that caused the loss of 22,146 human lives. Subsequently, the drought of 2005 produced losses in the agricultural sector of 28 million tons of products. More recently, in July 2021, devastating floods affected Switzerland, Germany and Belgium, with 229 fatalities and material damage estimated at more than 2.5 billion euros. Finally, in 2022, Storm Eunice caused at least 14 deaths and notable economic impacts yet to be quantified, as reported by the Spanish press.[1]

Beck (1998) points out that natural risks respond to natural dynamics that negatively affect social dynamics increasingly due to human activity. For this reason, we must reconsider the relationship between both systems (social-ecological) (Berkes and Folke 1998). The theory of social-ecological systems has the potential to equate both dimensions (Berkes 2017), confronting the frequent theoretical constructions that falsely endow institutions (the anthropic part) with a hegemonic power capable of transforming and controlling nature. Nevertheless, in terms of risk management, it is essential to consider the social structure. The impacts of a natural disaster will not be the same across space due to differences in political configurations and socioeconomic infrastructures (Natenzon 1995). The participation of all involved sectors and interests is decisive when proposing policies for preventing, adapting to, and mitigating natural disasters (see Armonia Project 2006). Stakeholder interactions condition the resulting actions whose objective must be to reduce unnecessary exposure and decrease vulnerability.[2]

Spatial planning, based on strategical approaches (Albrechts 2004) and including a regulative dimension (Farinós and Peiró 2022), contributes to the conception and application of public policies aimed at the well-being of society in each territory (Galland and Enemarck 2013). On this basis, following de Graff and Dewulf (2010), spatial planning represents “a public-sector-led (Kunzmann 2000) sociospatial (Healey 1997) process through which a vision, coherent actions and means for implementation are produced that shape

[1] https://www.elmundo.es/internacional/2022/02/19/6210c8fd21efa0883f8b45e6.html

[2] Nouzari et al. (2020) consider the changes introduced by the European Flood Directive by incorporating the Flood Risk Management Plan. One important aspect is the change in the scope of action, now linked to the river basin. Although this makes more sense from the territorial point of view, the given environmental dynamics that cause the risks do not necessarily adjust to political-administrative borders. Nevertheless, this increases the complexity because of the increase in administrations and levels as well as a larger group of actors. As a result, growth interests become contested, generating new opportunities and dependency relationships (Seher and Löschner 2016). For this reason, these authors advocate the development of interactive governance, which can be understood as a set of guiding principles or dimensions to facilitate the participation of interested parties, thus reducing the judicialization of conflicts, as usually happens in planning and implementation.

and frame what a place is and may become" (Albrechts 2004, p.471). It includes progressive actions to reduce natural risk, which, within the significant change experienced in the last two decades, not only implement the structural actions put in place after the occurrence of some episode of catastrophic effects but also try to anticipate and adapt to the aim of increasing the effectiveness and reducing the cost of anthropogenic interventions in the environment (Olcina and Oliva 2023).

Planning can reduce vulnerability by reducing risk through appropriate land use planning that lessens overexposure. Planning integrates the issue of risks among its tasks (Ran and Nedovic-Budic 2016). However, this greater sensitivity to the climate issue does not always contribute to a renewed understanding and reconceptualization of spatial planning (Farinós 2021), nor does take a multi-threat or multi-risk approach that allows an overall perspective on the possible incidence of certain events. Rather, this happens in very few cases that are classified as good practices.

If climate change contributes to extreme events with greater frequency and intensity and increasing danger, inadequate land use exacerbates risks even more (Benito et al. 2005; Farinós 2021).[3] Spatial planning must incorporate these considerations to reduce vulnerability in a space that concentrates population, facilities and activities as the basis for estimating the potential for loss and damage. Spatial planning should combine preventive actions to adapt territories (ex ante) with mitigation interventions (ex post). The answers must refer to each space and different periods (short, medium and long term).[4]

Spatial planning[5] becomes the appropriate tool for the effective management of limited economic resources aimed at responding to issues arising from natural risks and the induction of transformations in social structures. Spatial planning:

– Is a space to link the development of decision-making routines (based on multilevel coordination and cooperation) and the effective broad participation of the public (including civil society) and private sectors.

[3] The effects of climate change are manifesting with increasing frequency and intensity, with more extreme climatic situations. Thus, for example, in 2020, the highest temperature ever seen in Antarctica (18.3 °C) was recorded. In 2021, unusual temperatures of more than 25 °C were recorded continuously during the first three weeks of July in Finland, which reached the maximum temperature ever recorded in summer (33.5 °C). Additionally, Sweden surpassed any historical record of maximum temperatures, and in Canada, large-scale forest fires broke out after reaching temperatures of 49.6 °C. Spain set a new historical temperature record in April 2023.

[4] The inflows of risk premiums not used for compensation are invested in the market to generate profits for the future, as a typical circle of capitalist accumulation that ceases to be profitable only when the level of disasters (and their magnitude) is such that the so-called technical reserve is exceeded (Von Dahlen and Von Peter, 2012).

Paradoxically, the main loss for insurance companies came from the 2008 stock market crash, not from disasters. The scenario is complex because, as stated by Shiller (2012, cited in Domínguez and Domínguez 2014), based on the experience of the 2010 earthquake in Haiti, the lack of insurance leads to a lack of compensation that hinders the socioeconomic recovery of those affected. All this is in the context of a lack of supervision in construction and building regulations by companies, although they correspond to a public sector that develops them through its own spatial and urban planning system.

[5] The economic costs of dealing with the growing effects of climate change lead to the development of structural changes that modify the behaviour of social and economic systems to reduce the impact on ecosystems. The economy, as noted by Löschnel et al. (2017) based on a CS linked to river flooding scenarios in various municipalities in Austria, requires an integrative consideration of the local determinants of flood risk to increase the effectiveness of adaptive management, given the existing resource limitations.

- Is a space for the coherence of sectoral policies through a cross-sectoral/integrated approach to improve their effectiveness.
- Combines statutory and flexible approaches, providing legal certainty to decision-making legitimated by citizen and stakeholder participation (Farinós and Peiró 2022).[6]
- Helps to demonstrate facts, patterns and trends based on territorial information that uses graphic representation as a support tool for decision-making (Fleischhauer et al. 2007). Decision-making processes are favoured if updated data and maps are available.[7]
- These decision-making processes constitute tools for promoting participation based on the information-knowledge-opinion-action sequence (Farinós et al. 2017) and risk management (Ran and Nedovic-Budic 2016). However, they present some limitations, as they can mask decision-making (Mileu and Queirós 2018).

International agreements relate spatial planning to DRM and CCA. In this line, the United Nations Sendai Framework for Disaster Risk Reduction 2015–2030[8] introduced two main changes from its predecessors: an emphasis on DRM (rather than disaster management) and disaster risk reduction as an expected outcome. In the second case, new risks should be prevented, existing risks should be reduced, and resilience should be strengthened through state policies aimed at preventing and reducing the risk of disasters through the active participation of all state institutions and all society. Thus, the Sendai Framework explicitly admits the following:

(a) The need for a better understanding of disaster risk in all dimensions related to exposure, vulnerability and hazard characteristics.
(b) The strengthening of disaster risk governance.
(c) The recognition of stakeholders and their roles. Therefore, governance acquires importance by being developed mainly through territorial policy.[9]

[6] The French region of New Aquitaine, one of the CSs of this paper, is an example of integration. There, integration between spatial and sectoral planning takes place through a figure such as the Schémas régionaux d'aménagement, de développement durable et d'égalité des territoires. This planning instrument articulates other instruments: the Regional Plan for Ecological Coherence; the Regional Climate, Energy and Air Plan; the Regional Plan for Infrastructures, Transport and Intermodality; and the Regional Plan for Waste Management and Prevention.

[7] Planning support systems (PP-GIS (public participation GIS) or PP-GIT (public participation geographic information technology)) appear as a result of combining spatial decision support systems (derived from the decision support systems developed in the 1970s to solve economic and business problems) and the rise of participatory planning (Farinós and Sánchez Cabrera 2010; Rall et al. 2019; cited in Gómez et al. 2022).

[8] It was adopted at the third United Nations World Conference in Sendai, Japan, on March 18, 2015. It is the successor of the Hyogo Framework for Action 2005–2015: Increasing the Resilience of Nations and Communities to Disasters. The Hyogo Framework tried to give further impetus to global work on the 'International Framework for Action of the International Decade for Natural Disaster Reduction' (1989) and the 'Yokohama Strategy for a Safer World: Guidelines for the Prevention of Natural Disasters, Preparation for Disasters and Mitigation of Their Effects' and its plan of action (both adopted in 1994), and the 'International Strategy for Disaster Reduction' (1999).

[9] Several projects and publications study the relationship between governance and urban and spatial planning, such as the ESPON 2.3.2 Project 'Governance of Territorial and Urban Policies', the ESPON TANGO Project 'Towards Better Territorial Governance in Europe', the ESPON Territorial Governance and Spatial Planning-COMPASS Project 'Comparative Analysis of Territorial Governance and Spatial Planning Systems in Europe', Farinós and Gonzalez (2021), Nadin et al. (2021), and Stead (2021). All highlight the diversity of planning practices and approaches depending on each context. The classification of spatial planning policy, legal instruments and tools can add more detail to studies of policy styles, considering this background and knowledge in this article.

Considering the experience gained from the implementation of the Hyogo Framework for Action 2005–2015,[10] States must take specific actions in all sectors at the local, national, regional and global levels in four priority areas:

(1) Understanding disaster risk: Disaster risk management policies and practices imply understanding disaster risk in all its dimensions: vulnerability, capacity, the degree of exposure of people and assets, the characteristics of hazards and related issues. A shared understanding is given in this paper, in which we consider risk = hazard · exposure · vulnerability; all of these are related but different concepts. If exposure (i.e., socioeconomic elements) is '0' (not any element), there will be no real risk (mainly in economic terms). Therefore, natural risks are not an appropriate term; rather, natural hazards/menaces or socioeconomic risks are better terms (due to high exposure and vulnerability because of the lack of appropriate spatial planning).

(2) Strengthening disaster risk governance to DRM: It is necessary to have clear objectives, plans, powers, guidelines and coordination within and between sectors and to enhance the participation of relevant actors and strengthen disaster risk governance for prevention, mitigation, preparation, response, recovery, and rehabilitation. Such strengthening encourages collaboration and alliances between mechanisms and institutions to apply relevant instruments for disaster risk reduction and sustainable development. Contributing to achieving this:

    (a) incorporating and integrating disaster risk reduction in all sectors in a coordinated manner and examine and promote the coherence and further development of national, regional and local frameworks of laws, regulations and public policies.
    (b) encouraging legislators to support the implementation of disaster risk reduction measures by developing relevant new legislation, amending existing legislation, and establishing budget allocations. Investing in disaster risk reduction for resilience.

(3) improving preparedness for effective disaster response and "building back better" by recovering, rehabilitating or rebuilding.

3 Hypothesis, research questions and methodology

This article aims to provide evidence on how good territorial governance practices can reduce direct and indirect economic losses due to natural hazards. The hypothesis is that spatial planning instruments represent the European Union policy as an appropriate tool

[10] It made it possible to draw lessons and detect shortcomings and future challenges (up to a total of 15 are included in the final document of the Sendai Framework), among which we highlight the following: (5) It is urgent and essential to anticipate the risk of disasters, plan measures and reduce this risk to more effectively protect individuals, communities and countries, their livelihoods, their health, their cultural heritage, their socio-economic assets and their ecosystems, thus strengthening their resilience. (13) It is necessary to address climate change as one of the factors that drive disaster risk… for which… (14) It is necessary to address current challenges and prepare for future challenges by focusing on the following actions: monitoring, assessing and understanding disaster risk and sharing that information (and the method to produce it); strengthening disaster risk governance and coordination in relevant institutions and sectors as well as the complete and meaningful participation of relevant actors at appropriate levels.

Table 1 Overview of the TITAN case studies. Source Farinós, Pinazo, Peiró, Rodríguez 2023

Study case	Country	Risks	Policy levels	geographical scale
Rotterdam	NL	Floods	National	City
Prague	CZ	Floods	National	City
Po River Basin	IT	Storms Earthquake	National and regional	Region (Lombardia)
Pori	FI	Floods	National	City
Andalucía	SP	Floods Storms	National and regional	Constitutional Region
Nouvelle-Aquitaine region	FR	Storms (1999) Storms (2010)	National	Region
Dresden	GE	Floods (2002) Floods (2010) Floods (2013)	State and federal	Region
Alpine region	Transnational	Several	International protocols	Euroregion

for disaster risk management (DRM) and climate change adaptation (CCA) measures. This hypothesis responds to international agreements, such as the agreement mentioned above. On this basis, the research questions are as follows:

- Which instruments and policies regarding DRM (e.g., hazard maps, disaster management plans, compulsory insurance) and CCA exist for territories at different policy levels?
- To what degree are DRM and CCA measures integrated into spatial planning and territorial development policies?
- How do the territorial impacts of natural hazards affect the territory? Do coherent policies, by integrating DRM and CCA strategies into spatial planning instruments, change the results? What could be the recommendations for policy-makers?

Eight CSs were selected and analysed (Table 1) to answer the questions above. The CSs were selected considering how well they illustrate diverse types of risk, geographical contexts, risk management/prevention practices, planning systems traditions and scales/levels of decision (Grieving and Navarro 2022). In this way, the method aims to verify the theoretical approaches by studying the CSs.

This paper collects the main results from the analysis of these eight CSs based on a matrix of analysis questions defined for the TITAN project: (i) geographic, economic and demographic characterization; (ii) the main characteristics of the administrative structure and planning system; (iii) the economic impacts of natural disasters in the case study area; (iv) DRM at the case study level (responsible institutions in risk prevention and risk assessment); (v) CCA at the case study level (climate change impact assessment and CCA); and (vi) lessons learned.

This led to a summary report of the set of CSs in terms of the following items: (1) the existing baseline; (2) DRM formal measures highlights; (3) any common/overall DRM approach (preventive, measure, responsibilities…); (4) the interlinkages of different kinds of measurements; (5) the important additional value of practice beyond formal planning; (6) CCA; (7) cooperation and coordination; and (8) lessons learned.

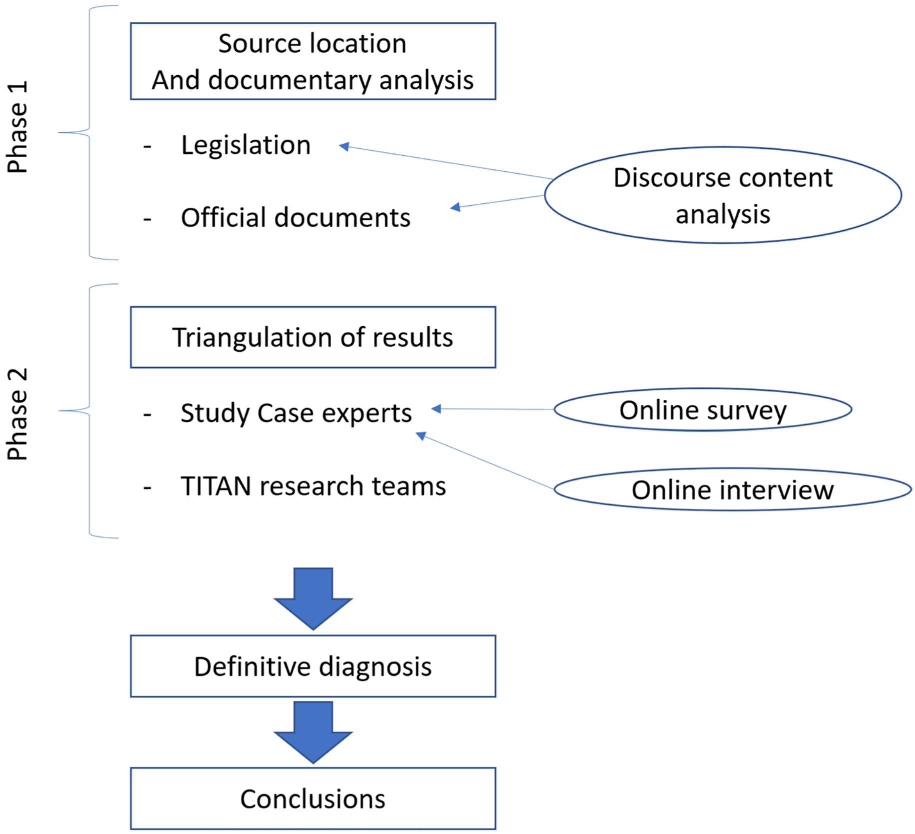

Fig. 2 Flowchart of the methodological process. *Source* Farinós, Pinazo, Peiró, Rodríguez 2023

From this work, it was possible to identify the main spatial planning instruments and tools used by responsible public administrations (at different scales, following a multilevel perspective) for natural risk management and the fight against climate change as well as their level of effectiveness. The point of departure was that prevention measures are preferable to adaptation and mitigation measures, both of which are necessary for any strategy to fight against climate change and appropriately manage natural risks. In this sense, spatial planning represents the best alternative for articulating effective responses spatially (due to its multilevel approach) and temporally (due to its prospective vocation).

We also carried out a search, selection and analysis of the contents of public policy documents to illustrate the foci of the selected cases. This research involved two methodological phases (see Fig. 2). The first was source location. Second, we performed a content analysis of published documents and regulations (see Appendix). Both phases started with a research question to answer through inferences drawn from texts: What is the relation between spatial/urban planning and risks? Thus, we proceeded to locate and collect the available written information (from bibliographies, legislations or reports). Thus, for the set of technical and legal texts, we conducted discourse content analysis following Krippendorff (2004), as performed in other works at the European level (Elissalde et al. 2013). Subsequently, in the second phase, using the triangulation technique, the results of the first phase were refined and validated at two stages and two levels. First, triangulation was performed with the experts responsible for each case study through a web questionnaire and, later, through a telematic interview (see Table 2). Second, triangulation was performed with the rest of the TITAN Project participant research teams. On this basis, the diagnosis was obtained, and the conclusions were developed and checked with the rest of the project teams before their final drafting.

Specifically, in this second phase of triangulation, through a telematic questionnaire, we obtained a characterization of the particularities of each territory, namely, the territorial distribution of risks, the impacts they produce, their costs, and an identification of the responses of the different administrations involved to this situation. In this way, we developed an inventory of initiatives (political, legal) and sectoral planning instruments (statutory or strategic) to respond to the effects of natural risks associated with CC. From this work, it was possible to establish some first typologies.

Stakeholders in the study areas, owing to interviews with them, verified our proposal. The interviews included personnel with diverse profiles, but all were linked to the issue of risk management in their respective territories: political representatives, administration technicians, experts from academia/research centres, private actors (practitioners) and members of civil society. Then, we presented the different reports to the interested parties and the rest of the teams participating in the TITAN Project. Doing so resulted in a series of relationships between types of phenomena, planning styles and territories with specific characteristics, which could allow extrapolation to other European spaces.

On this basis, we present a characterization of the risk assessment system in each CS, as well as the way policy-makers develop evidence to manage risks at different levels and the role that spatial planning plays in DRM and CCA. In addition, we perform a SWOT analysis for the set of cases. These results are processed in the discussion section. The structure for the information is a CAME (correct weaknesses (C), fight threats (A), maintain strengths (M), and exploit opportunities (E)) analysis. From the CAME analysis, we present a series of conclusions and recommendations, which can contribute to improving the evaluation of public policies, giving rise to a new conceptual and analytical model still under discussion (see, in this regard, initiatives such as that organized by the JOINT ACSP-AESOP Session: Inclusive Climate Action Planning in Europe and America in November 2022).

4 Results

In this section, we present the detailed information collected from each of the eight CS reports and Annex 5 of the ESPON-TITAN Scientific Report: Case Study Synthesis.[11]

Although the cases respond to different scales, countries have strategies or plans for CCA and DRM at the national level, from which they develop measures at the regional or local levels (in this way, clearly following a hierarchical principle). All CSs reflect the importance of setting common standards for DRM and CCA strategies within the European Union at the supranational level (i.e., European institutions), as reflected in the success of Flood Risk Management Directive 2007/60/EC.

[11] All reports are available at https://www.espon.eu/natural-disasters.

Table 2 Profile list of interviewees by case study. *Source* Farinós, Pinazo, Peiró, Rodríguez 2023

Case study	No. people	Institution	Position
Rotterdam	2	Municipality of Rotterdam	Senior advisor flood Risk Management
			Senior advisor flood Risk Management
Prague	3	Prague Institute of Planning and Development	Head of Office / Unit of Technical Infrastructure
			Water Management specialist
			EU and International Relations Specialist
Po River Basin	3	Regione Lombardia	Regional Territorial Department Mountain
			Directorate-General for Territory and Civil Protection, Urban Planning and Spatial planning, Hydrogeological Planning, Networks and Water State Property
			Civil Protection
			Head of Organizational Position "Territory security and soil defense", internal expert with the functions of secretary taking the minutes
			Head of the "Coordination of Employment Centres" Department – Executive "Coordination Public Employment Services"
City of Pori	3	Municipality	Project worker for Interreg Baltic Sea Region NOAH-project
			Civil engineer constructor at City of Pori
			Design engineer of Flood Risk Management
Andalucía	3	Regional administration. Andalusian Government. CAGPDS	Head of Service
		Regional Ministry of Development, Infrastructures and Planning. Andalusian Government	General Directorate of Urban Planning and Territory Planning
		Ministry of Agriculture, Livestock, Fisheries and Sustainable Development	Head of Environmental Assessment and Analysis Service
Nouvelle-Aquitaine region	2	DREAL Nouvelle-Aquitaine	Head of the Hydrometry and Flood Forecasting Department, Deputy Head of the Natural and Hydraulic Risks Department
		Prefet de la Dordogne	Departmental Directorate of Territories

Table 2 (continued)

Case study	No. people	Institution	Position
Dresden	5	TU Dortmund University	Senior Researcher
		Regional Planning Association for the Upper Elbe Valley/Eastern Ore Mountains	Renewable energies/use of wind energy, technical infrastructure including transport and technical protection of the environment
		State Office for the Environment, Agriculture and Geology	Head of Department – Water, Soil, Recyclables
		Fire department/rescue service/disasters and civil protection	Fire Chief (Retired in 2021)
		State Capital Environmental Office	Chief of the Office of Fire and Disaster Control
Alpine region	4	Ministry of Environment and Supervisor, Directorate for Spatial planning, Construction and Housing, Slovenia	Member of the Slovenian delegation to the Standing Committee of the Alpine Convention
		Federal Ministry of Agriculture, Regions and Tourism, Section III – Forestry and Sustainability, Department III/4 – Torrent and Avalanche Control and Forest Protection Policy, Austria;	Member of Action Group 8 of EUSALP; Member of the Natural Risks Platform (PLANALP) of the Alpine Convention
		Hidrotehnik Vodnogospodarsko podjetje d.o.o., Slovenia;	Member of the Natural Hazards Platform (PLANALP) of the Alpine Convention; Member of the EUSALP Action Group 8
		Vienna University of Technology, Institute for Spatial planning	Land Policy and Management Research Area

The public sector is the leading actor in DRM and CCA through public policies and their creation and implementation, which combine preventive and adaptative measures. The spatial planning role in this is clear. Comprehensive plans provide the opportunity to coordinate actions and budgets and involve stakeholders and civil society. Among the activities, spatial planning includes both ex ante (adaptation and prevention) and ex post (repairing once the event causes damage) measures. The private sector focuses its activity on economic compensation, mainly related to property and based on the economic pursuit of profit. This is the case for insurance companies involved in the cases of the city of Pori, covering the repair costs because of floods, and Andalusia, where agricultural insurance plays a fundamental role in compensating for the losses of farmers after climatic events such as floods, storms and hail.

The split between ex ante and ex post has analytical relevance only for showing how the public and private sectors participate in DRM and CCA. From an applied perspective, planning should include preventive and adaptative measures with protocols to act after the events. Although emergency protocols and strategies are formulated (ex ante), they are not usually related to other planning elements. For example, the city of Pori does not produce risk management plans in collaboration with spatial planning, although risk and hazard maps are available for use in spatial planning (according to the interviewed stakeholders). However, in other cases, they are well connected. In the case of Andalusia, the planning and management of the risk of flooding, associated with a specific hydrographic demarcation, are framed in water sectoral planning (hydrological planning). This planning relates to other planning instruments (especially land use and urban planning plans) and other sectoral planning areas (civil protection plans, infrastructure management or agriculture). Therefore, flood risk planning and management interact with other planning domains at the local level in land use planning in the Spanish case. Similarly, in the Po River basin, according to the Regional Spatial Planning Law of the Lombardy region, it is mandatory to carry out geological, hydrogeological and seismic hazard analyses in the preparation of each level of urban planning. In this context, civil protection plans (at all levels) consider hazards, scenarios and actions to mitigate the consequences if an event occurs.

The results from the case studies also confirm the importance of broad involvement and participation in DRM and CCA as a condition for achieving good risk governance. The cases of the Dresden region, the city of Pori, the Po River Basin, Nouvelle-Aquitaine, Rotterdam and the Alpine region show the importance of involving citizens and the private sector in these strategies. In the case of Dresden, the Saxony Climate Network (Klima-Netzwerk Sachsen) is a think tank in which authorities, universities and research institutes work together to strengthen their relationship. In the case of the city of Pori, the so-called flood groups interact with fluvial demarcation and the significant coastal zone of risk, as well as with operators, land and water owners, water users and representatives of organizations, during various stages of the preparation of the Flood Risk Management Plan. The Po River Basin case illustrates how this collaboration and cooperation between actors are a source of innovation, such as collaboration between the private sector and universities, to develop new solutions and skills. The Nouvelle-Aquitaine case shows how local governments have developed strategies to involve citizens and stakeholders in protecting communities (e.g., the Survey 17 project, the MAREA project, or the Semaphore tool). In this line, the Rotterdam Delta programme includes the participation of stakeholders in developing CC impact assessment maps. In addition, stakeholders participate in the evaluation of different alternatives for adaptation. This process is known as the 'risk dialogue'. The success of the INTERREG programmes in the Alpine region, which create a framework for exchange and cooperation between economic, environmental and social actors by bringing together representatives from science, politics, business and innovation, is another example of good practice. Finally, the cases of the cities of Pori and Andalusia also illustrate the importance of educating and raising awareness among citizens about natural risks and their consequences as well as the importance of immediate actions (e.g., emergency telephone numbers available during the event).

Risk assessment helps policy-makers develop evidence for DRM frameworks at different territorial scales. In this sense, one of the results is that it is necessary to include risk assessment methodologies. As the Dresden CS demonstrates for floods, prevention areas are a solution based on the intensity of the hazard, considering parameters such as flow velocity and water depth rather than the probability of occurrence. Moreover, it is necessary to complement historical information (i.e., the return period) with methodologies based on prospective scenarios, such as the CSs of the city of Pori, the Po River Basin or the Dresden region. In this way, spatial planning becomes preventive and proactive because it combines historical data on the most vulnerable areas and future scenarios for adaptation to new dynamics and threats of climate change. The cases of Prague and Andalusia, based solely on the exploitation of historical data for risk assessment, illustrate the opposite model based on reaction. The data on the consequences of natural disasters in these two opposing methodological typologies (proactivity vs. reaction) support the suitability of the first model.

What is this situation in practice? Table 3 summarizes the findings extracted from the analysis of CSs to determine which criteria could define good and effective DRM practices and performance. According to the table, the geographical context and the importance given to conditions create differentiated behaviours among the case studies. Indeed, conditions produce the main consensus (6 or more CSs recognize their importance for 16 of the total 23 criteria/conditions). The less recognized are those referring to an improvement in quality ('regular update of assessments', 5 of 8 CSs) and innovation ('consideration of cascading effects', 'innovative strategies', 5/8 CSs; 'multi-hazard risk assessment', 'territorial approach', 4/8 CSs; and 'cross-border assessment and management initiatives', 3/8 CSs). In extreme situations, there are two conditions. In a positive way, 'specific sectoral management plans and instruments' (recognized in 8/8 CSs) correlate with low recognition of the territorial approach, as integrated and the opposite of the sectoral approach, which is the most common approach. Less recognized is 'integration of DRM and CCA in planning laws' (1/8 CSs) due to the little desire for more regulation to drive own management. Joining risk management improvement and no more regulation leads us directly to new governance practices as the desired way to follow and confirms the starting hypothesis regarding 'functional' governance over 'territorial' governance.[12]

Regarding the dynamics of each CS, its scale and the geographical context it represents, the tradition/style of planning seems to be a better factor than scale (local/city instead of regional, national or supranational). Therefore, the CSs of the Dresden region (Germany), Nouvelle-Aquitaine (France), Rotterdam (the Netherlands), Po River Basin (Italy) and City of Pori (Finland) belong to countries or territories with an advanced planning style of an

[12] Blatter (2004) consider territorial governance more formalized and closer to spatial planning, contrasting it with the functional approach (more versatile and fluid), which is less stable in time and space. Functional governance works with network interaction, multiple and diffuse scales, and variable geometries, responds to specific questions and tasks, and is closer to cooperation (Farinós and Gonzalez 2021).

Table 3 Criteria/conditions for good and effective practice of DRM. *Source* Farinós, Pinazo, Peiró, Rodríguez 2023

Criteria	N.	Alpine Region	Andalusia	City of Pori	Dresden Region	Nouvelle Aquitaine	Po river Basin	Prague	Rotterdam
Provide data	7	-	X	X	X	X	X	X	X
The collaborative approach across sectors	7	X	X	X	X	X	X	-	X
Vulnerability data	7	-	X	X	X	X	X	X	X
Multi-hazard risk assessment	4	-	-	-	X	X	X	-	X
Tools for prioritizing and risk mapping	7	-	X	X	X	X	X	X	X
Consideration of critical infrastructures	7	-	X	X	X	X	X	X	X
Scenarios of future development	6	-	X	X	X	X	X	-	X
Provide quantitative results	7	-	X	X	X	X	X	X	X
Provide results in maps	7	-	X	X	X	X	X	X	X
Regular update of assessments	5	-	-	X	X	X	X	-	X
Coordination of all involved stakeholders	7	-	X	X	X	X	X	X	X
Stakeholder involvement	6	X	-	X	X	X	X	-	X
Consideration of cascading effects	5	-	-	X	X	X	-	X	X
Parallel modelling approach	6		X	X	X	X	X	-	X
Integration of climate change	6	X	X	X	X	X	-	-	X
Cross-border assessment and management initiatives	3	X	-	-	X	X	-	-	-
Integration of DRM and CCA in planning laws	1	-	-	-	X	-	-	-	-
Primary integration of risk assessment & management into spatial planning processes	7	-	X	X	X	X	X	X	X
Territorial approach	4	-	-	-	X	X	X	-	X
Planning instruments, including Environmental Impact Assessment	7	-	X	X	X	X	X	X	X
Hazard zoning as a basis for planning decisions	7	-	X	X	X	X	X	X	X
Specific sectoral management plans and instruments	8	X	X	X	X	X	X	X	X
Innovative strategies (no regret strategies; retreat; burden sharing)	5	-	-	-	X	X	X	X	X
TOTAL FREQUENCY IN THE CS		5	15	18	23	22	19	13	21

integrated nature based on the classification included in the different projects and scientific literature already cited in footnote 8. In the second tier, the CSs of Andalusia (Spain) and Prague (Czech Republic), respectively, correspond to traditional normative land use planning (urbanism tradition) and a new member state in Central Europe. There is a lower frequency of answers in the case of the Alpine region, one can imagine, because this is not a topic in which the region has competence and it is not explicitly included in transnational agreements, even though the region has a desire for 'cross-border assessment and management initiatives', a criterion/condition recognized in only two more CSs (regions of Dresden and Nouvelle-Aquitaine) (see Table 3).

As a result of the quantitative and qualitative data collected for each CS, we reveal the results regarding the effectiveness of spatial planning for DRM. Within the analysis of the case studies, Table 4 shows the economic impact of the different natural events analysed in this research.

In all cases, except for the Alpine region CS, for which there is not enough information, the severity of the economic impact caused by natural events is highlighted. Furthermore, the analysis shows how investing in prevention drastically reduces losses. Specifically, the city of Pori CS shows the effectiveness of the prevention measures implemented because river floods tend to occur on a regular basis every 10–20 years; however, due to flood risk management, in the last 50 years, there have been no extreme flood events. The information obtained for the Rotterdam CS reveals that the more recent floods had no significant economic impact in the area located within the banks. The data analysis of the Po River Basin shows that the floods that occurred in 2014, 2016, 2018 and 2019 caused less damage than previous floods caused by the infrastructures built. In the same line, comparing the impacts of events that occurred before and after the implementation of prevention measures, the Nouvelle-Aquitaine region CS reveals that the 1999 Cyclone Lothar and Martin had economic impacts more than three times greater than those of the 2010 Cyclone Xynthia, even if the implemented measures did not work as well as planned. Furthermore, the Dresden CS shows the downward trend in the Elbe River flood economic impact, with a decrease from 1.8 billion euros in 2002 to 0.85 billion euros in 2010 to 0.56 billion euros in 2013 due to the implementation of prevention measures. All these case studies are good examples of advanced planning styles of an integrated nature.

On the other hand, the Prague CS shows that prevention pays off even if it is implemented in a reactive way (correction) rather than through integration. The economic impact of the 2013 flood in Prague was lower than that of the 2002 flood, as central areas of Prague did not suffer damage since the post-2002-developed flood protection measures protected them. Even if the economic impact of the 2013 flood is unknown, the 4 billion Czech koruna spent by the government to address the consequences of flooding indicates a minor cost.

Finally, the cost of intervention measures implemented to prevent damage may not consider the impact on nature and its costs. Engineering responses to DRM and CC can alter ecosystemic dynamics. The European Union is promoting nature-based solutions as an alternative to traditional approaches. Nature-based solutions represent an umbrella concept inspired and supported by nature; are cost effective; simultaneously provide environmental, social and economic benefits; and help build resilience. Such solutions, which include green and blue infrastructure, bring nature and natural features and processes into cities, landscapes and seascapes through locally adapted, resource-efficient and systemic interventions.[13]

This section ends with the following SWOT analysis of the 8 CDs from an integral perspective:

[13] https://cordis.europa.eu/article/id/421771-nbs-benefits-and-opportunities-wild-et-al-2020

Table 4 Economic impact information[a,b] *Source* ESPON TITAN PROJECT CS reports

Study case	Risk	Sector affected	Direct cost (Euro)	Indirect cost (Euro)
Andalucía	Floods and Storms	Emergency works	18 million	
Prague	Floods (2002)	Total costs	(27 billion Czech koruna)	
	Floods (2013)	Total costs	(4 billion Czech koruna)	
Rotterdam	Actual Floods	Financial (Expected outside the Banks)	36 million/year	–
		Settlements (Expected outside the Banks)	2–14 million	–
Po River Basin	Storms (1987)	Total costs	2.1 billion present value	
Pori	River Floods	Total costs expected in worst case scenario	3 billion	
Nouvelle-Aquitaine	Storms (1999)	Total costs	6.9 billion	
	Storms (2010)	Total costs	1.5 billion	
Dresden	Floods (2002)	Total costs	1.8 billion	
	Floods (2010)	Total costs	0.85 billion	
	Floods (2013)	Total costs	0.56 billion	
Alpine region	Not enough information			

[a]It summarizes the economic information presented in the individual reports (the values presented do not follow a common methodology and were not calculated within ESPON-TITAN – they were indicated by each case individually in https://www.espon.eu/natural-disasters)

[b]More Quantitative economic impact information was available for some CS, as 11,2 million Euro impact of the 2004 and 2012 earthquake in the Po River basin, or the 39,4 million Euro damage cost caused by pluvial floods in the city of Pori, but not inserted in this table as no comparable information was available in the other CS

Strengths
- A clear and general recognition that current threats are modified and increased by the effect of climate change, which affects policy development
- Regulatory and instrumental frameworks are increasingly used at the European, national and regional levels
- A general understanding of broad involvement and participation in DRM and CCA as a condition for achieving good risk governance
- Increasing availability of geographic information
- Risk map elaboration identifies the most vulnerable areas. Rotterdam's Weather Wise, Urgent Document is a good example. It includes up-to-date risk maps and a description of the problem and methodology for building the map (technical innovation), the location of vulnerable objects, challenges, and responsible actors. The document defines three components: (1) to know: information related to the effects of changes in the climate through impact assessments or stress tests that are developed and specified in maps and research; (2) "WANT" or "RISK DIALOGUE", from which a climate agenda can emerge: the participation of stakeholders in the content of the map and deliberation to identify what is considered relevant and what is not, based on the costs associated with certain decisions; (3) WORK: actions derived from the integration of the climate agenda in the planning system to carry out research or generate knowledge, social actions (such as communication, stimulation) or related territorial actions, for example, greening areas and vegetation (as a new green infrastructure, 20 hectares of green spaces was added by 2022 compared to those existing in 2018)

Weaknesses
- Natural regions do not correspond to political-administrative borders. Therefore, natural resource management and implementation do not occur in general terms in the most appropriate areas for them to be effective
- There is a direct relation between the density of socioeconomic activities and the risk and vulnerability to threats
- Productive mono-specialization increases risk and vulnerability in economic terms, as in the Alpine region (tourist activity), the Po River Basin in Lombardy (creative and cultural industries), and the Dresden region (secondary sector industry and activities)
- There is evidence of a lack of continuous and up-to-date information related to the economic costs of disasters during the events and, above all, of those that follow, both the most common direct (those that refer to damage to the capital stock) and the least usually considered indirect (those associated with the interruption of economic activity in related regions) costs
- Budgets prepared for investments related to prevention and adaptation are quantified less frequently. These costs are closely related to the role of insurance companies
- Reactive policies are more frequent than proactive policies. Most risk assessments and climate change adaptation measures operate in areas that are developed and consolidated. Consequently, many activities are located in hazardous areas, which can potentially be affected by future events, necessitating a political and economic effort in terms of re-planning and the reallocation of uses and development
- Spatial planning and civil protection are often not well connected

Opportunities
- Risks are inevitable but managed more appropriately and safely
- The rehabilitation of urban areas is usually more demanding and requires more time and resources. Therefore, a proactive approach is much more efficient than a reactive approach, although the latter may end up being first, depending on the urgency and needs
- Introducing adaptation measures in spatial planning (aligned with the EU Green Deal) is one example of how a multilevel approach to spatial planning promotes better management of natural hazards

Opportunities
- The behaviour is different from case to case, using traditional land use planning formulas (Andalusia, Po River Basin, city of Prague), innovation (Rotterdam), or a combination of the two (city of Pori, Nouvelle-Aquitaine region)
- Spatial planning represents a tool for achieving long-term adaptation to climate change (CLISP Alpine Space: 47). Several relevant documents related to climate adaptation also give spatial planning a role. The European Commission's White Paper emphasizes its role in climate adaptation issues. Spatial planning should include prevention (proactive), mitigation and adaptation (reactive) activities regarding climate change. Mitigation and prevention measures need to be maintained
- The strategic component in spatial planning allows us to focus on the medium and long term, improving the balance of the effects caused by natural disasters (in economic, human, and environmental terms). In this way, authorities should focus their investment on prevention management instead of adaptation and mitigation policies, although such investment is less profitable in the short term
- The Dresden and Rotterdam regions are good examples that illustrate this situation with the construction of infrastructures that reduce the impact of natural phenomena. Contrary to short-termism, it is possible to adapt policies and actions to the current hardening of natural events derived from climate change, improving the results of these policies. The case of the city of Pori is another example of prevention and the maintenance of structures that protect from floods. The Po River Basin shows that although the events are more intense due to climate change and despite the increase in anthropic pressure, the damage caused is less than in the past owing to these structures

Threats
- Current threats are modified and increased by the effect of climate change, as verified in diagnoses and stated in the preambles that justify new pieces of legislation. New anthropic activities are at risk now. Sea level rise and regime change in weather events are becoming more extreme and recurrent, as in the CSs of the Po River Basin, Lombardy, Nouvelle-Aquitaine and the city of Pori
- Similar to droughts and earthquakes, floods affect a larger area than storms or landslides, which are more localized and cause direct and indirect economic impacts and losses in rural and urban areas. These floods, the most widespread and harmful phenomenon, are becoming more intense and recurrent. In addition, the combination of phenomena increases the damage, enhanced by climate change
- The effects and costs of natural disasters are not measured correctly, as the consequences over time are not considered alongside the immediate costs
- The challenge affects both future projects and those that were carried out in the past: many urbanized areas are in risk zones, as in the cases of the city of Pori, the Po River Basin or Nouvelle-Aquitaine
- A top-down hierarchical approach to risk management is still predominant. On the other hand, in planning instruments, relationships are more heterarchical. This situation can lead to a lack of harmony between the two
- Urban agglomerations and their growth, sometimes not compatible with the new conditions, affect the ecosystems and natural resources of nearby urban and rural areas

5 Discussion

The contents of this section follow a CAME (correct weaknesses (C), fight threats (A), maintain strengths (M), and exploit opportunities (E)) analysis structure to provide a series of key messages and recommendations regarding how new spatial planning tools can or cannot help DRM and CCA:

5.1 To correct weaknesses

There is evidence of a lack of continuous and up-to-date information related to the economic costs of disasters during events and, above all, of those that follow them (both direct and indirect).

Achieving better adequacy between political and ecologically functional regions and establishing cooperation rules between different administrative units improve the performance of management efficiency and results. In this sense, cross-border cooperation is relevant for spatial planning, DRM and CCA. The CSs show how this cooperation must exist between regions within the same country (as in the case of the Po River Basin, where there is active coordination of actions at the river basin level) and between countries. For example, in the Dresden region, Germany cooperates with Poland and the Czech Republic in terms of flood risk management, flood risk assessment and spatial planning; additionally, in the Alpine region, cooperation to protect inhabitants and infrastructure against natural hazards and develop appropriate preventive measures occurs between Germany, Austria, France, Italy, Liechtenstein, Monaco, Slovenia and Switzerland. The latter case shows the importance of transnational programmes such as the EUSALP or INTERREG and transnational projects such as GreenRisk4Alps.

Regarding adaptation to climate change, adaptation strategies and action plans developed at the national and regional levels should be transferred to the local level through adaptation measures because the impact ultimately occurs at the local level. France is an example of a transfer from the national level to the local level due to the coordination of national and supra-regional uses in an integrated manner. This is possible because of new instruments of integrated inter-sectoral planning, which must modify new land uses that are the responsibility of local authorities. In the cases of Andalusia and Pori, local planning takes place in cities. There are also groupings of municipalities for this purpose, such as in the Po Valley and Nouvelle-Aquitaine.

Vertical coordination and cooperation are essential for DRM and CCA. Some good examples include the common geographic information platform of the Po River Basin case study, the role of civil protection in the Andalusian case study, and the interactive and online tools for DRM that improve cooperation between different administrative levels and the inclusion of citizens in the Dresden region. At other times, local action occurs through specific projects and measures well integrated into previously defined plans and programmes (Pori and Rotterdam and with a more reactive ex post in the case of Prague).

Cooperation structures between different administrative levels are needed, as are those between experts, based on a balanced set of formal and informal elements. Following the examples of the Alpine region, the Dresden region, and the Po River Basin, long-lasting, sustainable and effective cooperation should respond to formal agreements, complemented by interpersonal connections based on mutual trust and an open mind to share experiences and learn from others.

A comprehensive approach to spatial planning is preferable to a purely sectoral approach because it allows synergies and meeting points between different areas and it manages possible conflicts of DRM and CCA between policies. In this sense, the CSs of Rotterdam (with the new National Strategy on Spatial Planning and the Environment (NOVI)) and Nouvelle-Aquitaine (with the Regional Plan for Spatial Planning and Sustainable Development (STRADDET)) show how DRM can be performed in an integrated way and improve its results. In the Dresden region, spatial planning coordinates sectoral policies, integrating plans at the same level into a single instrument, and improves the connection between spatial planning and civil protection. In most CSs, spatial planning is an administrative coordination process based on a land use perspective and a sectoral approach that includes decisions on DRM and CCA previously argued.

5.2 To fight threats

There is an urgent need to take into account activities not previously threatened by natural hazards (and, therefore, that were not at risk). Threats can also worsen if they become even more dangerous when combined with other phenomena in the current climate change context.

It is necessary to respond to unavoidable residual risk through disaster management when an event occurs. In addition, it is necessary to consider its consequences over time. The Dresden region is an example of an alert and rescue system; Andalusia copes with post-event impacts through a compensation system; and the Po River Basin stands out due to the relevance of community action in emergency management.

The public sector should review and update recurrence periods because climate change increases recurrence in short-term return periods (e.g., storm floods with a recurrence period of 10 years in Rotterdam) and long-term return periods. The public sector has an opportunity to include this information in climate change adaptation strategies, planning instruments and action plans and programmes.

Productive mono-specialization increases risk and vulnerability in economic terms. On the opposite, this approach is suitable for fostering economic and land use diversification. Similarly, the gradual relocation of uses in confirmed risk areas is convenient. Many built-up areas are in risk zones, as in the city of Pori, the Po River Basin or Nouvelle-Aquitaine. For these cases, possible solutions could include the gradual relocation of these urban areas, the use of insurance to mitigate the effects of natural phenomena or the rehabilitation of constructions and infrastructures that are able to withstand the effects of these events. The case of the city of Pori, which includes flood areas on developable land for economic infrastructure and green or public spaces (as an example of green infrastructure and nature-based solutions), shows that land uses can also be combined in the event of a natural disaster (if prevention measures are implemented and insurance is contracted).

5.3 To maintain strengths

The public sector can identify vulnerable areas through risk maps. Furthermore, proactive preventive spatial planning can use information and scenario formulation. Regarding hazard dynamics (e.g., climate change) and vulnerability (e.g., urban growth or social inequalities), any hazard assessment, including hazard maps, should be based not only on the past but also on future dynamics and the most vulnerable areas in some scenarios.

It is important to consider climate change scenarios to mitigate the potential impacts of risks associated with natural hazards. In Rotterdam, in addition to the traditional maps, other additional maps are produced, including rainfall, heat, droughts, floods, groundwater, and land subsidence maps, as well as a map of opportunities, which should be taken into account, to define futures (visions) for more precise planning in the future.

Although spatial planning cannot contribute to avoiding damage in already built areas at risk, since growth and territorial transformation occur, in most cases, as previously developed by sectoral policies, spatial planning is a powerful tool for including measures to correct and prevent risk and anticipate its effects (mapping the current situation and introducing feasible scenarios and alternatives).

5.4 To exploit opportunities

Spatial planning represents a tool for achieving long-term adaptation to climate change. Integrating DRM into spatial planning through risk and hazard mapping improves outcomes. This fact is already noted in Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007, which raises the need to use cartography (well-defined risk maps). Observatories (as in the cases of Rotterdam or Nouvelle-Aquitaine) improve spatial planning results due to the production of data and complementary information published in scientific reports. Dresden shows that dynamic cartography allows multilevel analysis through geographic information systems that bring value to the management of the territory, both for the development of contingency plans and for spatial planning decision-making. In this sense, the CSs emphasize the importance of handling up-to-date data.

Vertical coordination and cooperation are relevant for DRM and CCA. Good examples include the common geographic information platform in the Po River Basin, the role of civil protection in the case study of Andalusia, and the interactive and online tools for DRM that improve cooperation between different administrative levels in the case study of the Dresden region (e.g., INGE for municipal flood protection or the RAINMAN toolbox). The opposite case, in which a top-down vision predominates, is found in the case of the Alpine region, where climate change adaptation strategies and action plans are developed at the regional level. However, localities rarely implement adaptation measures, leaving them without the resources to face natural disasters or adapt to climate change. In addition, the CSs show the relevance of cooperation structures between different levels of administration and between experts based on a balanced set of formal and informal elements. The CSs of the Alpine region, Dresden region, and Po River Basin highlight that lasting, sustainable and effective cooperation should respond to formal agreements. In addition, interpersonal connections based on mutual trust and an open mind to share experiences and knowledge improve the results.

The results of DRM improve when there is a clear identification of the persons in charge at each level and their responsibilities through binding laws and documents. The cities of Pori and Rotterdam reflect the importance of including prevention measures in the law, their maintenance periods and the frequency of updated risk maps. The case of the Po River Basin is an example of legally linking risk assessment with spatial planning. In this case, the planning process integrates risk maps, and their absence invalidates the plan. In this sense, the CSs reflect the importance of the local level in implementing good DRM since the local level is the level closest to citizens, those who know the problems of the territory and those responsible for its coordination. However, the case of the Po River Basin highlights the importance of providing support from the regional and national levels to the local level in the form of know-how and financial resources. The lack of financial resources is one of the reasons authorities at the local level focus on mitigation activities rather than prevention. Along these lines, the cases of Rotterdam and Pori point out the insufficiency of the resources of local entities to implement DRM strategies and why local taxes are thus proposed as a complement.

The strategic component of spatial planning allows us to focus on the medium and long term. Authorities should focus their investment on prevention management instead of adaptation and mitigation policies, although such investment is less profitable in the short term. Investing in risk prevention is worthwhile as demonstrated in all CSs. All ESPON-TITAN CSs have suffered a disaster. However, the introduction of preventive and adaptive measures reduces economic impacts. Of course, damage arises where preventive actions are non-existent. Preventive measures represent an additional cost (prior investment is necessary to identify the appropriate benefits). However, it ends up being more strategic (in the end, sometimes even less expensive) to invest in preventive measures than to pay for ex post (unforeseen) measures for recovery after a dangerous event.

In this line, the CSs show that the increase in anthropic pressure in urban areas and nearby rural areas, derived from the growth of cities and human activity, must be mitigated through the implementation of new ways of urban growth and more sustainable and cohesive urban development that improves the urban-ecological relationship. The aim is to promote land use and urban sprawl in a different form, clever, sustainable and resilient, reinforcing proactive interventions and promoting soft interventions, including sustainable zoning, to reorganize the territory.

Hard and soft interventions combined improve the results to adapt and protect against natural risks. The former are measures based on technical rationality. There are examples in almost all the CSs: dikes in Nouvelle-Aquitaine to protect against the sea; the construction of dikes, canals and dams in the city of Pori; dams and barriers in the case of the Czech Republic; and the delta system in the case of Rotterdam or dikes and dams in Dresden. Their popularity responds to the accumulated experience using these interventions, making them more attractive for decision-makers, politicians and technical teams in the public sector and for the companies that benefit from this type of project.

Soft interventions implement nature-based solutions. They use the ecosystem services provided by green and blue infrastructures. These are less developed and, therefore, less experience with them has been accumulated. However, both types of interventions are complementary. Examples in some CSs include nature-based solutions such as soil barriers in the Czech Republic, the protocols on mountain farming and mountain forests and the Mountain Forests Working Group, which emphasize the importance of forests in the Alpine Region to reduce the impact of natural risks, or blue infrastructures in the case of Rotterdam. In this line, the CSs show that the increase in anthropic pressure in urban areas and nearby rural areas, derived from the growth of cities and human activity, must be mitigated through the implementation of new ways of urbanizing and more sustainable and cohesive urban expansion that improve the urban-ecological relationship. The aim is to promote sustainable and resilient land use and urban growth, reinforcing the argument that proactive and preventive spatial planning promotes soft interventions, such as the reorganization of territory through alternative forms of zoning.

6 Conclusions

Current threats are modified and increased by climate change. Reactive policies are more frequent than proactive policies. Most risk assessments and adaptations to climate change are not preventive because they act in areas where the urbanistic process has finished, forcing a significant political and economic effort to re-plan and reallocate uses and development. Productive mono-specialization increases risk and vulnerability; thus, there is a need to reinforce economic and land use diversification.

Authorities should focus their investment on prevention management instead of adaptation and mitigation policies, although such investment is less profitable in the short term. The data on the consequences of natural disasters in these two opposing methodological typologies (proactivity vs. reaction) support the suitability of the first model. It is more strategic (in the end, profitable and sometimes even less expensive) to invest in prevention than to pay for (never planned) ex post measures for recovery after a hazard event. Although there is information available, it refers mainly to natural events that have already happened. In this sense, it is essential to continue supporting, if there is a preventive vocation, the development of future scenarios. Directive 2007/60/EC insisted on cartography that combines spatial planning and natural risk management as tools for effective decision-making.

A top-down hierarchical approach in risk management is predominant. For this reason, it is important to identify the persons in charge and detail their powers related to DRM through binding laws and documents to improve the results. There is little will to increase regulation to boost self-management for risk management improvement, and there is no more normative means to develop new governance practices as a path to follow, thus confirming the starting hypothesis.

On the other hand, in planning instruments, relationships are more heterarchical, leading to a lack of harmony between DRM and spatial planning. Better integration between spatial planning and risk planning and management could be guaranteed by including the risk dimension in the strategic environmental assessment (SEA). In this sense, good government became a precondition for governance.

As stated in the ESPON-TITAN Scientific Report-Annex 4 Policy Instruments, spatial planning improves the management of natural risks by contributing to the following:

- Integrating DRM and CCA in land laws.
- Incorporating natural risks as a conditioning criterion in decision-making processes from the first stages of spatial planning onwards, not as a simple sectorial cartographic complement.
- A broader territorial approach: identifying management options that mitigate risks as a whole instead of following only unrelated sectoral policies.
- Improving spatial planning and environmental assessment instruments.
- Hazard zoning as a basis for spatial planning decisions.
- Developing specific sectoral management plans and instruments.
- Taking advantage of the strategic component of planning to go beyond the usual political-administrative logics that are not operational in issues related to the environment while achieving binding agreements between political parties, with a fair distribution of responsibilities and rights to guarantee the viability and effectiveness of the measures in terms of risk prevention and management.

Interventions in terms of adaptation and protection are coming from an engineering logic, with more weight and legitimacy, offering business opportunities to companies specializing in this type of territorial intervention. Gradually, nature-based solutions (which prove socially and economically profitable and simultaneously provide environmental benefits, in addition to helping to create resilience) are being increasingly used (European Environment Agency 2021). Such solutions bring more nature and greater diversity to cities, landscapes and seascapes through locally adapted, resource-efficient and systemic interventions. Proactive and preventive spatial planning promotes these soft interventions.

The aspects considered necessary and desirable for effective natural risk management still follow an empiricist-positivist logic. This logic is very favourable for engineering-based individual interventions that do not respond to the new forms of territorial-based coordination or to the development of soft measures that affect the social component as much as the territorial component. However, as a source of legitimacy, spatial planning requires a renewed understanding of social knowledge, advocating that spatial planning also has the possibility of providing objective readings in an approach that tries to go beyond both the naturalistic-deterministic dichotomy and the radical contextualism leading to relativism (Gabriel 2021).

Even though technology will continue to play a fundamental role in our current societies (as the European New Green Deal reminded us), it does not solve all problems. As the strategic approach to spatial planning reminds us, an alternative functioning should respond to a renewed social and institutional mission to sustain public action.

This paper shows the coexistence of both trends and some innovations in the preventive approach that deserve consideration based on a better analysis of the effects and costs that the natural risks associated with climate change and global warming are causing. Some of these measures must be accompanied by changes in the current development and consumption model, as proposed by the new United Nations 2030 Agenda (UN 2015).

Appendix

See Table 5

Table 5 List of documents analysed by case study. *Source* Farinós, Pinazo, Peiró, Rodríguez 2023

Case study	Title	Year	Scope
Rotterdam	Rotterdam weather wise urgency document	2020	Climate change adaptation
	Rotterdam climate change adaptation strategy	2013	Climate change adaptation
	Rotterdam municipal sewerage plan GRP	2021	Water management
	National delta act	2012	Risk Management
	National delta programme	Yearly report	Water management
	Summary national policy strategy for infrastructure and spatial planning	2011	Regional development
	Climate atlas province of South Holland	updatable	Climate change adaptation
	Spatial vision of infrastructure and territory management (SVIR)	2012	Regional development
	The spatial planning act—WRO	1962	Spatial and urban planning
	Water Act	2010	Water management
	Waterplan 2	2007	Water management
	National strategy on spatial planning and the environment (projected) (NOVI)		Regional development
Prague	Prague land use plan	1999	Spatial and urban planning
	Strategy of Regional Development of the Czech Republic 2014–2020	2013	Regional development
	Act No. 183/2006 Coll: Builging Act	2006	Spatial and urban planning
	Act No. 240/2000 Coll: Crisis Management Act	2000	Risk management
	Capital City of Prague Climate change Adaptation Strategy	2020	Climate change adaptation
	Strategy on Adaptation to Climate change of the Czech Republic	2015	Climate change adaptation
	Common spatial development document of the V4 + 2 countries	2010	Spatial planning and governance
	Act No. 254/2001 Coll: Water Act (Amended in 2009)	2001	Water management

Table 5 (continued)

Case study	Title	Year	Scope
Po river basin	Legge 18 maggio 1989, n.183 Norme per il riassetto organizzativo e funzionale della difesa del suolo Testo della legge 183/89 integrata con la legge 253/90 e con il decreto legge 398/93 convertito con la legge 493/93	1989	Land Use
	n. 12Legge Regionale 11 marzo 2005, n. 12 Legge per il governo del territorio (B.U.R.L. n. 11 del 16 marzo 2005, 1° s.o.) (ultimo aggiornamento: legge regionale 24 giugno 2021, n. 11)	2005	Spatial planning and governance
	DECRETO LEGISLATIVO 3 aprile 2006, n. 152b Norme in materia ambientale	2006	Risk management
	D. Lgs. 2 January 2018, n.1 – Codice della Protezione Civile	2018	Civil protection
	• l.r. 11 March 2005 #12—(Legge per il Governo del Territorio)	2005	Spatial planning
	l.r. 15 March 2016 #4—(Revisione della normativa Regionale in materia di difesa del suolo, di prevenzione e mitigazione del rischio idrogeologico e di gestione dei corsi d'acqua)	2016	Risk management
	l.r. 22 May 2004 #16	2004	Civil Protection
	Regional Climate change Adaptation Strategy of Lombardy Region	2014	Climate change adaptation
	Regional Action Plan for Adaptation to Climate change	2016	Climate change adaptation
City of pori	Land Use and Building Act (Maankäyttö- ja rakennuslaki 132/1999)	1999	Spatial and urban planning
	Flood Risk Management Act (Laki tulvariskien hallinnasta 620/2010)	2010	Flood risk management
	Flood Risk Management Plan of the Kokemäenjoki river (2016–2021)	2015	Flood risk management
	Flood Risk Management Decree (Valtionneuvoston asetus tulvariskien hallinnasta 659/2010	2010	Flood risk management
	Dam Safety Act (Patoturvallisuuslaki 494/2009	2009	Dam management
	Rescue Act (Pelastuslaki 379/2011)	2011	Civil Protection
	Water Act (Vesilaki 578/2011)	2011	Water management
	Act on Environmental Impact Assessment of Government Plans and Programs (SOVA, Laki viranomaisten suunnitelmien ja ohjelmien ympäristövaikutusten arvioinnista 200/2005)	2005	Environmental impact assessment
	Act on Environmental Impact Assessments (Laki ympäristövaikutusten arviontimenettelystä 468/1994)	1994	Environmental impact assessment
	National Strategy for Adaptation to Climate change	2005	Climate change adaptation
	Pori General plan for the inner city to 2025 (Kantakaupungin yleiskaava 2025)	2008	Spatial and urban planning

Table 5 (continued)

Case study	Title	Year	Scope
Andalucía	Experiencia del Paisaje, movilidad y red viaria	2016	Infrastructures (green and gray)
	Atlas de la Historia del Territorio de Andalucía	2009	Territory
	Programa de Desarrollo Rural de Andalucía 2014/2020	2014	Regional development (special focus on rural)
	Plan INFOCA	2011	Forest fires
	Plan de Prevención de avenidas e inundaciones en cauces urbanos andaluces	2002	Urban floods
	Law 17/2015, of July 9, on the National Civil Protection System (Ley 17/2015, de 9 de julio, del Sistema Nacional de Protección Civil)	2015	Civil Protection
	Basic Civil Protection Standard—Royal Decree 407/1992, of April 24 (Norma Básica de Protección Civil—Real Decreto 407/1992, de 24 de abril)	1992	Civil Protection
	Law 2/2002, of November 11, on Emergency Management in Andalusia (Ley 2/2002, de 11 de noviembre, de Gestión en Emergencias en Andalucía)	2002	Civil Protection
	Law 5/2010, of June 11, on Local Autonomy of Andalusia (Ley 5/2010, de 11 de junio, de Autonomía Local de Andalucía)	2010	Governance
	Plan Territorial de Emergencia de Andalucía (PTEAnd)	2011	Governance
	Royal Decree 903/2010, of July 915, of evaluation and management of flood risks	2010	Flood risk management
	Ley 87/1978 de Seguros Agrarios Combinados	1978	Insurance
	Royal Decree 2329/1979 that establishes the Development Regulations (Reglamento de Desarrollo)	1979	Insurance
	Decree 63/1995, which regulates subsidies for agricultural insurance in Andalusia	1995	Insurance
	National Climate change Adaptation Plan	2021	Climate change adaptation
	Plan Andaluz de Acción por el Clima	2010	Climate change
	Programa Andaluz de Acción por el Clima	2010	Climate change
	Ley 8/2018, de 8 de octubre, de medidas frente al cambio climático y para la transición hacia un nuevo modelo energético de Andalucía	2018	Climate change
	Ley Ordenación del Territorio		Spatial planning
	Plan de Ordenación del Territorio Regional		Spatial planning

Table 5 (continued)

Case study	Title	Year	Scope
Alpine region	Alpine Convention Protocols and Declarations	ND	Governance
	Strategy for the Alpine Space (EUSALP)	ND	Governance
	INTERREG III B Alpine Space Programme	2000	Risk prevention
	INTERREG IV B Alpine Space Programme	2008	Risk prevention
	INTERREG V B Alpine Space Programme	ND	Risk prevention
	Climate change, Impacts and Adaptation Strategies in the Alpine Area. Strategic project. (ClimChAlp. Klimawandel, Auswirkungen und Anpassungsstrategien im Alpenraum Strategisches Interreg-III-B-Alpenraum-Projekt)	ND	Climate change adaptation
	Hazard maps, intensity maps and hazard index maps. (Gefahrenkarten, Intensitätskarten und Gefahrenhinweiskarten)	2020	Risk management
	Multi-Annual Work Programme of the Alpine Conference 2017–2022	2017	Climate change adaptation
	Alpine strategy for adaptation to Climate change in the field of natural hazards	ND	Climate change adaptation
	Climate Adaptation Governance in the Alpine Space Transnational Synthesis Report (WP1)	2019	Climate change adaptation
	Climate change Adaptation by Spatial planning in the Alpine Space Climate change Fitness of Spatial planning Synthesis Report (WP5)	2011	Spatial and urban planning
	Natural Hazard Risk Governance: Status Quo in the EUSALP Region. EUSALP Action Group 8	2019	
	Climate Neutral and Climate Resilient Alps 2050. Innsbruck Declaration Alpine Climate Target System 2050 (Klimaneutrale und klimaresiliente Alpen 2050. Deklaration von Innsbruck Alpines Klimazielsystem 2050.)	2019	Climate change adaptation
	Alpine Conference Session: Action Plan on Climate change in the Alps. (Tagung der Alpenkonferenz: Action Plan on Climate change in the Alps)	2009	Climate change adaptation

Table 5 (continued)

Case study	Title	Year	Scope
Dresden	Federal Building Code (Baugesetzbuch BauGB)	1997	Spatial and urban planning
	Federal Regional Planning Act (Raumordnungsgesetz ROG)	2008	Spatial and urban planning
	Saxon State Law on Fire Safety, Emergency Services and Civil Protection (Sächsisches Gesetz über den Brandschutz, Rettungsdienst und Katastrophenschutz)	2004	Civil protection
	Saxon Regulation on Fire Fighters (Sächsische Feuerwehrverordnung)	2005 (modified in 2020)	Fires
	Saxon Water Act (Sächsisches Wassergesetz)	2004 (Several modifications 2013–2022)	Water management
	Water Management Act (Wasserhaushaltsgesetz)	2009	Water management
	Civil Protection and Disaster Assistance Act (Zivilschutz- und Katastrophenhilfegesetz)	1997 (modified in 2020)	Civil protection
	Earthquake standard (Erdbeben norm)	ND	Earthquake
	Flexilibisierung der Planung für eine klimawandelgerechte Stadtentwicklung	2013	Spatial and urban planning
	Bundesministerium für Verkehr, Bau und Stadtentwicklung (2013): Wie kann Regionalplanung zur Anpassung an den Klimawandel beitragen? Ergebnisbericht des Modellvorhabens der Raumordnung „Raumentwicklungsstrategien zum Klimawandel " (KlimaMORO)	2013	Spatial and urban planning and climate change
	Bundesministerium für Verkehr und digitale Infrastruktur (2015): Vorsorgendes Risikomanagement in der Regionalplanung (MORO) Endbericht	2015	Risk management
	Flächennutzungsplan in den Stadtgrenzen vom 1. Januar 1999 Begründung. Fassung vom 6. Juni 2019	1999	Spatial and urban planning
	LFULG – Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie (ed.) (2013): Ereignisanalyse Hochwasser im August und September 2010 und im Januar 2011 in Sachsen. Dresden	2013	Flood risk management
	LFULG—Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie (2017): Starkregenereignisse von 1961 bis 2015	2017	Storm risk management
	Regional plan Oberes Elbtal/Osterzgebirge 2. Gesamtfortschreibung 2020, beschlossen als Satzung durch Beschluss VV 02/2019 der Verbandsversammlung am 24.06.2019, genehmigt mit Bescheid des Sächsischen Staatsministeriums für Regionalentwicklung vom 08.06.2020, wirksam seit 17.09.2020 mit Bekanntmachung der Genehmigung im Amtlichen Anzeiger des Sächsischen Amtsblattes Nr. 38/2020 vom 17.09.2020	2020	Spatial and urban planning

Table 5 (continued)

Case study	Title	Year	Scope
Nouvelle-Aquitaine	Regional planning, sustainable development, and equality schemes (SRADDET)	ND	Risk management/spatial and urban planning
	Climate, Air and Energy Regional Plan (SRCAE)	ND	Climate, air and energy management
	Ecological Consistency Regional Plan (SRCE)	ND	Climate change adaptation
	Infrastructures, Transportations and Inter-modality Regional Plan (SRIT)	ND	Infrastructure and transportation plan
	Risk prevention plan (PPR)	ND	Risk management
	Flood Prevention Action Programme (PAPI)	ND	Water risk management
	Local urban development plan (PLUI)	ND	Spatial and Urban planning
	Lessons from the 2010 Atlantic Coast Floods (Xynthia). Summary of the thematic public report	2012	Risk management
	Risk maps and cartography of indicators. New Aquitaine Regional Risk Observatory ORRNA. Observatoire Régional des Risques Nouvelle-Aquitaine	ND	Risk management
	French National Assembly Informative Report of the National Assembly No. 2697 – “The reasons for the damage caused by storm Xynthia. Rapport d’information de l’Assemblée nationale n°2697—« Les raisons des dégâts provoqués par la tempête Xynthia»	2010	Risk management

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References

Albrechts L (2004) Strategic (spatial) planning reexamined. Environ Plann B Plann Des 31(5):743–758

Anderson J, Bausch C (2006) Climate change and natural disasters: Scientific evidence of a possible relation between recent natural disasters and climate change. Policy brief for the ep environment committee IP/A/ENVI/FWC/2005–35. https://www.europarl.europa.eu/meetdocs/2004_2009/documents/dv/ieep_cc_natural_disasters_/ieep_cc_natural_disasters_en.pdf. Accessed 05–09–2022

Armonia (Applied multi risk mapping of natural hazards for impact assessment) (2006) Assessing and mapping multiple risks for Spatial planning. Approaches, methodologies and tools in Europe. Summary document

Beck U (1998) La sociedad del riesgo. Hacia una nueva modernidad. Paidós, España

Benito G, Corominas J, Moreno JM (2005) Impactos sobre los riesgos naturales de origen climático: Riesgo de crecidas fluviales. Evaluación preliminar de los impactos en España por efecto del cambio climático. Informe final Proyecto ECCE. Ministerio de Medio Ambiente, 525–548

Berkes F, Folke C (eds) (1998) Linking social and ecological systems: management practices and social mechanisms for building resilience for complexity and change. Cambridge University Press, Cambridge

Berkes F (2017) Environmental governance for the Anthropocene? Social-ecological systems, resilience, and collaborative learning. Sustainability 9:1232. https://doi.org/10.3390/su9071232

Blatter J (2004) From 'spaces of place' to 'spaces of flows'? Int J Urban Reg Res 28(3):530–548

CEMAT (European Conference of Ministers Responsible for Regional Planning) (1983) European Regional/Spatial planning Charter (Torremolinos charter). Strasbourg: Council of Europe

Colding J, Barthel S (2019) Exploring the social-ecological systems discourse 20 years later. Ecol Soc 24(1):2. https://doi.org/10.5751/es-10598-240102

De Graaf RS, Dewulf GPMR (2010) Applying the lessons of strategic urban planning learned in the developing world to the Netherlands: a case study of three industrial area development projects. Habitat Int 34:471–477

Von Dhalen S, von Peter G (2012) Catástrofes naturales y el reaseguro mundial: ¿cuáles son sus vínculos? Informe Trimestal del BPI. Diciembre de 2012. https://www.bis.org/publ/qtrpdf/r_qt1212e_es.pdf. Accessed 05–09–2022

Domínguez N, Domínguez JM (2014) El impacto económico de los desastres naturales. Extoikos 15:99–101

Elissalde B, Santamaria F, Jeanne Ph (2013) Harmony and melody in discourse on European cohesion. Europ Spatial Plan 22(3):627–647. https://doi.org/10.1080/09654313.2013.782389

EUEC (2006) REPORT on Natural Disasters (fires, droughts and floods) - environmental aspects. Committee on the Environment, Public Health and Food Safety. https://www.europarl.europa.eu/doceo/document/A-6-2006-0149_EN.html

European Environment Agency, Castellari S, Zandersen M, Davis M (2021) Nature-based solutions in Europe policy, knowledge and practice for climate change adaptation and disaster risk reduction. Publ off. https://doi.org/10.2800/919315

Farinós J (2021) Hacia unas líneas de trabajo futuro en ríos y costas. In: Thomsen A, Farinós J, Perero E (eds) Soluciones ante los riesgos climáticos en ríos y costas. Fundación Conama, Madrid, pp 235–258

Farinós J, Gonzalez M (2021) La gobernanza territorial como concepto, proceso y resultado. In: Romero A, Alejo J (eds) Panorama de la Gobernanza: Perspectivas y retos para su estudio en iberoamericana. Tirant lo Blanch, Valencia, pp 147–168

Farinós J, Peiró E (2022) Propuesta de enfoque integrado en la elaboración del plan: el 'Smart Comprehensive Spatial planning.' In: Farinós J, Olcina J (eds) Ordenación del teritorio y medio ambiente. Tirant lo Blanch, Valencia, pp 743–763

Farinós J, Sánchez Cabrera JV (2010) Cambios recientes en los instrumentos de la política territorial en la Comunidad Valenciana. Límites al renovado papel del paisaje, de la evaluación y de la participación en la ordenación del territorio. Cuadernos De Geografía 87:45–64

Farinós J, Peiró E, Quintanilla P (2017) Cultura Territorial: de la información al conocimiento y el compromiso para la acción ciudadana. La iniciativa de la "Cátedra de Cultura Territorial Valenciana". Proyección 11:131–153

Farinós J, Peiró E, Rando E (eds) (2021) Evaluación de procesos: una mirada crítica y propositiva de la situación de la política e instrumentos de Ordenación del Territorio en España. Thomson Reuters Aranzadi, Navarra

Fleischauer M, Greiving S, Wanczura S (2007) Planificación territorial para la gestión de riesgos en Europa. Boletín De La a.g.e. 45:49–78

Gabriel M (2021) Ética para tempos oscuros Valores universales para el siglo XXI. Pasado y Presente, Barcelona

Galland D, Enemark S (2013) Impact of structural reforms on planning systems and policies: loss of spatial consciousness? Europ J Spatial Dev 11(3):1–23

Gómez M, Rodríguez-Espinosa VM, Salado MJ (2022) Aplicación de las tecnologías de la información geográfica en la elaboración de los instrumentos de ordenación del territorio. In: Farinós J, Olcina J (eds) Ordenación del territorio y medio ambiente. Tirant lo Blanch, Valencia, pp 616–642

Greiving S, Navarro D (2022) Territorial and Economic Impacts of Selected Natural Hazards in Europe. In press

Healey P (1997) An institutionalist approach to spatial planning. In: Healey P, Khakee A, Motte A, Needham B (eds) Making strategic spatial plans: innovation in Europe. Routledge, London, pp 21–36

Krippendorff K (2004) Content analysis. An introduction to its methodology, 2nd edn. Sage, Thousand Oaks

Kunzmann K (2000) Strategic spatial development through information and communication. In Salet WG, Faludi AK (Eds.) The revival of strategic spatial planning. Proceedings of the colloquium 25–26 February 199, Royal Netherlands Academy of Arts and Sciences, Amsterdam, pp 259–265

Mendonza D, Méndez A (2018) Evaluación de los costos económicos totales de los desastres naturales: inundación en la ciudad de Sheffield. Estudios Demográficos y Urbanos 33(3):699–732. https://doi.org/10.24201/edu.v33i3.1786

Mileu N, Quierós M (2018) Integrating risk assessment into spatial planning: RiskOTe decision support system. Int J Geo-Inf 7(5):184. https://doi.org/10.3390/ijgi7050184

Nadin V, Stead D, Dabrowski M, Fernández-Maldonado AM (2021) Integrated, adaptive and participatory Spatial planning: trends across Europe. Reg Stud 55(5):791–803. https://doi.org/10.1080/00343404.2020.1817363

Natenzon CE (1995) Catástrofes naturales, riesgos e incertidumbre. FLACSO. Serie Documentos e Informes de Investigación n, 197

Nouzari E, Hartmann T, Spit T (2020) Interactive governance for satisfaction measurements: stakeholder involvement in design processes for flood risk management. J Flood Risk Manag. https://doi.org/10.1111/jfr3.12650

Olcina J, y Oliva A (2023) Espacios de riesgo y ordenación del territorio en la Comunitat Valenciana: lecciones aprendidas en el Plan Vega Renhace. In: Farinós J (Coord.) II Informe sobre la evolución y la situación territorial de la Comunitat Valenciana. Publicacions de la Universitat de València, Valencia, pp 55–72

Rall E, Hansen R, Pauleit S (2019) The added value of public participation GIS (PPGIS) for urban green infrastructure planning. Urban Forestry Urban Greening 40:264–274. https://doi.org/10.1016/j.ufug.2018.06.016

Ran J, Nedovic-Budic Z (2016) Integrating Spatial planning and flood Risk Management: a new conceptual framework for the spatially integrated policy infrastructure. Comput Environ Urban Syst 57:68–79. https://doi.org/10.1016/j.compenvurbsys.2016.01.008

Seher W, Löschner L (2016) Balancing upstream-downstream interests in flood Risk Management: experiences from a catchment-based approach in Austria. J Flood Risk Manag 1:56–65. https://doi.org/10.1111/jfr3.12266

Shiller RJ (2012) Las finanzas en una sociedad justa. Deusto, Barcelona

Stead D (2021) Conceptualizing the policy tools of spatial planning. J Plan Lit 36(3):297–311. https://doi.org/10.1177/0885412221992283

Urquiza A, Cadenas H (2015) Sistemas socio-ecológicos: elementos teóricos y conceptuales para la discusión en torno a la vulnerabilidad hídrica. L'ordinaire Des Amériques. https://doi.org/10.4000/orda.1774