







## Article

# Comparison of Urban Climate Change Adaptation Plans in Selected European Cities from a Legal and Spatial Perspective

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**Abstract:** The aim of this paper is to identify and compare the key institutional features of urban climate change adaptation plans in three geographically, systemically, and climatically distinct European countries (Greece, Spain, and Poland). The paper concentrates on the tool indicated and confirms the circumstances and potential outcomes of its usage in the selected countries. A case study of a particular city was chosen in each country and the applicability of the climate change adaptation plan there was confirmed. Analysis was also performed on the plans' legal aspect, connection to national-level strategic planning, and spatial planning. The research questions formulated and addressed are as follows: how do urban climate change adaptation plans in the selected countries define key climate challenges? Is the content of the municipal climate change adaptation plans consistent with the content of the diagnosis of climate challenges at the supra-local level and in the scientific discussion? How are climate change adaptation plans translated into the implementation sphere? The example of Spain and Greece confirms that plans can combine general climate change adaptation objectives with specific (evasive) guidelines for urban policies, while the example of Poland shows that the content of climate change adaptation plans can often be too vague and difficult to further integrate into urban policies. The research results obtained are relevant from the perspective of comparing institutional responses to climate challenges. The research proposes possible methods for making such comparisons.

**Keywords:** climate protection; urban plans; local laws; climate challenges; urban adaptation plans; spatial planning



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## 1. Introduction

Responding to climate challenges requires tailored public policy responses. Climate changes vary both across different countries and within the same nation. Against this background, climate challenges seen in cities are particularly relevant [1,2] because they test public authorities on how they respond [3,4]. It is up to them to identify critical climate challenges at the city scale, as well as to recommend possible solutions and implement

them. This requires a variety of instruments, with climate change adaptation plans being one of the most popular [5]. These plans identify individual climate challenges and guide government-coordinated responses [6,7].

Urban climate change adaptation plans are commonly used by cities worldwide to address the challenges of climate change and mitigation. However, there is limited discussion in the literature about how effective these plans are and how they are put into practice. Many authors focus more on the issues these plans tackle rather than their actual implementation and impact [8–10].

Comparing municipal instruments in different countries needs a careful, balanced approach. Due to variations in legal systems, political structures, and socio-cultural factors, similar instruments may be implemented differently. An example of this is seen in the analysis of urban spatial plans [11–13].

Such plans share common features across different countries, yet their practical application differs. Municipalities encounter distinct spatial challenges when enacting them, a thing crucial to acknowledge in comparisons. Comparisons, in turn, can range from broader assessments involving more countries to detailed analyses focusing on fewer countries [14,15]. Detailed comparisons should primarily include countries within the same continent to maintain some socio-cultural cohesion. From a European perspective, it is vital to compare public policy instruments based on specific criteria:

- compare solutions between more vulnerable countries and less vulnerable ones [16];
- contrast approaches in Western European and Central and Eastern European countries [17].

Hence, this paper aims to identify and compare key institutional features of urban climate change adaptation plans in three European countries: Greece, Spain, and Poland. These are our three research questions:

- Does the content of municipal climate change adaptation plans align with the diagnosis of climate challenges at a broader geographical level and with the scientific discourse?
- How can/do legal and institutional conditions determine the effectiveness of implementing these plans?
- How do provisions within these plans translate into urban spatial planning?

The article also highlights problems in implementing urban climate change adaptation plans. It, therefore, provides a broader basis for discussing institutional responses to climate challenges. In part, it is a continuation of the authors' earlier consideration of the supra-local level.

The authors begin by outlining methods and explaining why they chose these three countries and the challenges they face. Next, they present a tabular summary of these issues and then analyze the primary climate challenges in each country, together with specific aspects related to implementing municipal climate change adaptation plans. Within the discussion, they then compare the features of these plans with the existing literature on institutional approaches to urban climate change adaptation. Additionally, they offer practical application guidelines for other countries and suggest potential research directions.

## 2. Literature Review

Comparing public policy responses across countries has been a common focus in various studies, covering a range of thematic contexts such as social, economic, and natural aspects. The authors of this study specifically concentrate on a highly relevant facet of spatial planning. Previous research by these authors explored the application of supra-local spatial planning instruments in various countries and their effectiveness in addressing climate challenges [18]. Obviously, urban design plays a fundamental role in climate protection efforts [16]. Summarizing the extensive literature on this topic, the following distinctions become manifest:

- The critical links between urban planning and climate challenges;
- The way city authorities should respond to such challenges institutionally;
- What is the relevance of urban climate change adaptation plans against this background?

As mentioned earlier, the specificity of climate challenges varies significantly across countries. However, the following topics are commonly highlighted in most studies:

- Protecting green open spaces [19–21];
- Shaping green infrastructure [22,23];
- Expanding environmental protection [24,25];
- Protection against weather hazards [26–28];
- Water management [29–31].

Spatial policy and the content of specific spatial planning instruments can potentially be tailored to address climate challenges. Achieving the objectives listed above requires a diverse range of solutions, as legal regulations alone may not suffice [32]. The literature emphasizes the role of strategic planning in this regard [33–35]. Strategic planning ensures that measures are set within specific timeframes, integrates various public policy directions by city authorities [36,37], and bases their actions on comprehensive expert analyses [38,39]. Piecemeal actions in a city, without broader reflection, may not yield long-term benefits. Strategic planning also allows for a flexible decision-making framework [40], enabling key objectives and challenges to be met optimally during the implementation phase [41,42].

Strategic planning can express itself in diverse documents [27]. Concerning climate challenges, climate change adaptation plans at the municipal level serve as a prime example in this regard [43]. Therefore, these plans should:

- Identify the challenges and aims for climate change adaptation in cities;
- Ensure a holistic view of these goals and challenges, especially from a cross-sectoral policy perspective;
- Provide an opportunity for flexible action, based on in-depth expert analyses.

Diverse and detailed discussions on the institutional factors influencing spatial planning are present within the literature, usually referencing specific instruments [44–46]. Articles focusing on climate change adaptation plans tend to concentrate less on the institutional roles of these instruments and more on the challenges outlined in the plans themselves [47]. A notable analysis by Aboyage and Sharifi [8] extensively compared the utility of climate change adaptation plans across different countries, primarily within the institutional and legal spheres. Addressing various specific issues within climate change adaptation plans, Tonmoy et al. [48] underscore the importance of intergovernmental cooperation for enhancing plan effectiveness. The literature also stresses the necessity of incorporating diverse interdisciplinary knowledge when formulating plans [49,50]. However, the following key conclusions emerge:

- Sanchez-Plaza et al. [51] emphasize the importance of thoroughly evaluating the findings of climate change adaptation plans. Jung et al. [52] explicitly point out the need for spot-checking the assumptions made in such plans [53].
- On the other hand, Lee et al. [54] stress the need for climate change adaptation plans to be based on in-depth, interdisciplinary studies. According to these authors, such studies will facilitate the evaluation of a plan's provisions.

The Spanish, Greek, and Polish literature also covers urban responses to climate challenges. In Greece, Yiannakou and Salata [55] discuss how urban planning can mitigate the urban heat island effect, while Dimelli et al. [56] highlight the link between climate vulnerability and inadequate urban planning in coastal areas. Santamouris et al. [57] propose a resilience plan incorporating climate change considerations and building resource utilization in city centers. Additionally, reflections on enhancing the resilience of Greek cities are explored separately [58]. The discourse includes discussions on implementing green infrastructure in cities [59] and examining the impact of climate change on the tourism sector [60].

The Spanish literature on climate challenges covers various fundamental areas. Authors discuss green infrastructure in cities to reduce CO<sub>2</sub> emissions [61–63], adapting urban centers to intense precipitation [64], addressing increasing urban temperatures [65] and the institutional dimensions of urban climate change adaptation [66].

Polish literature is also quite abundant. Research topics include decarbonization [67], promoting a closed-loop economy [12], addressing urban air pollution [26], rational water management, investment in blue-green infrastructure, and redefining public values about climate challenges [68,69].

To sum up, climate change adaptation plans feature prominently in the literature in terms of importance, tasks, and content. Rather patchy suggestions include evaluating plan implementation, basing content on expert analyses, and exploring the effectiveness of adaptation plans. Research gaps exist in understanding legal and institutional conditions that support plan implementation and comparative case studies across countries. In Greece, Spain, and Poland, there is a need to clarify the role of urban climate change adaptation plans and to relate them to national systemic conditions as well as to the barriers they face.

The overall role of spatial plans in climate change adaptation also needs to be considered [70]. First of all, it must be stressed that spatial plans at the local level vary greatly from country to country in terms of law, scope, and terminology [71]. This makes it difficult to give an unambiguous answer. Serious barriers, however, do not completely prevent comparisons from being made [13,72,73]. Therefore, it can be assumed that spatial plans can be produced by defining planning zones to co-shape the use of particular areas in cities [11]. For example, zoning residential development in areas of natural value may contribute to the deterioration of climate protection. Tailoring a particular type of spatial zone to the climatic needs of a particular part of the city can create barriers against overly hasty development in that part of the city;

- spatial plans also include development parameters (building height, building intensity, etc.). Moreover, these parameters can block or enable certain developments [74,75]. In addition, there is a need to include less frequently used parameters in the plans, e.g., forcing the planting of trees or the use of green roofs.

The content of spatial plans must be based on other documents. It is in this context that the urban climate change adaptation plans play such an important role. It is on the basis of the analyses contained in the climate change adaptation plans that planning zones or development parameters can be shaped according to climate needs. It should also be noted that local spatial plans can achieve the following:

- Facilitate investments in renewable energy sources [76–79];
- Prepare areas for the implementation of green infrastructure and in various other ways extend the range of green areas in cities (parks, green roofs, etc.), enabling the widest possible protection of nature in cities [80–82];
- Set aside space for climate shelters or emergency areas (in the context of sudden weather changes).

The function of spatial plans is, thus, essentially preventive and protective. Spatial plans can, however, shape individual directions regarding urban development. This is also why the integration of spatial plans and other development planning instruments is so important.

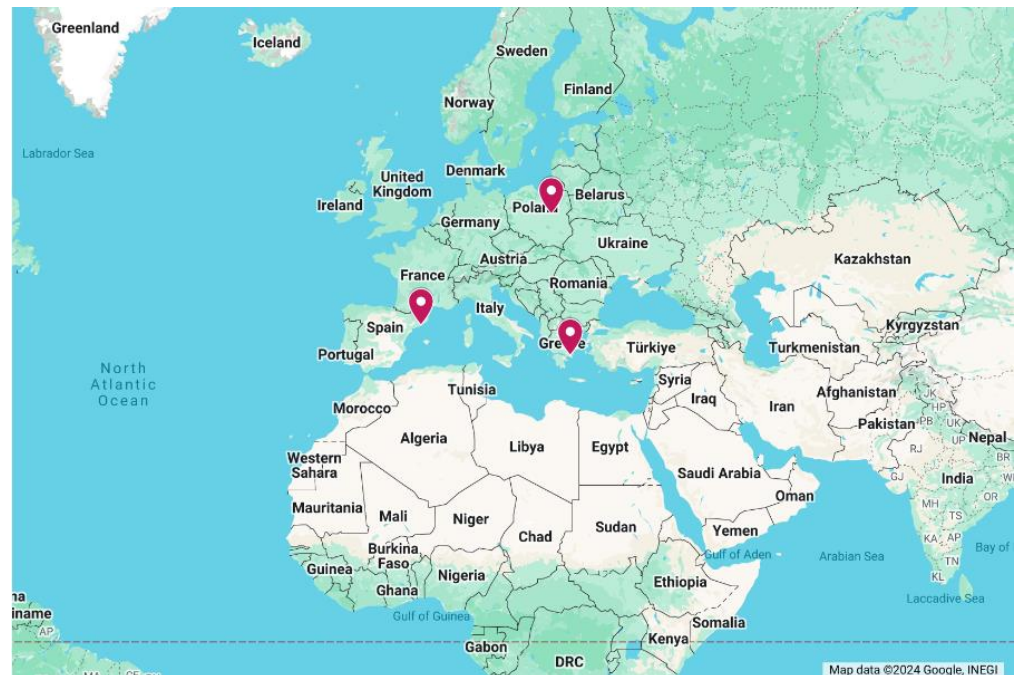
### 3. Materials and Methods

The article compares urban climate change adaptation plans from three European countries: Greece, Spain, and Poland (Figure 1).

This selection is justified as follows:

- They are states located in different parts of the same continent. This gives a certain coherence to their legal, political, and social features (manifested, among other things, by the fact that all of them are members of the European Union).
- Despite this consistency, there are also significant differences between them. Spain is a Western European country, Poland is a Central Eastern European country, and Greece is a Southern European country. The differences lie both in the levels of climate challenges and with the approaches to public policies [18]. Undoubtedly, it is interesting and necessary to compare public policy responses in these countries, especially when studying urban climate change adaptation plans. The countries

studied also have varying gross domestic product, with Spain having the highest and Greece the lowest [83].



**Figure 1.** Cities whose climate change adaptation plans were compared in the study. Based on Google Maps.

Each country has singled out a city for which a municipal climate change adaptation plan has been enacted: Athens, Barcelona, and Warsaw. It is possible to point out the specificity of climate problems in each of the cities studied:

- The climate challenges for Athens are extreme heat, urban heat island, energy consumption in municipal buildings and facilities, transportation, densely packed neighborhoods, and pollution—traffic congestion [57];
- The climate challenges for Barcelona are the need for a reduction in traffic and its emissions, the loss of thermal comfort (especially in summer), the increase in heavy rains, and the increase in the intensity of droughts and problems with urban water supply [84,85];
- The climate challenges for Warsaw include sudden weather changes and the progressive development of the urban heat island effect [26,86];

Athens has 664,046 residents. The lowest elevation point is 70.1 m, and the highest is 338 m. Barcelona has 1,660,122 residents. The lowest elevation point is 0 m and the highest is 512 m. Warsaw has 1,790,658 residents. The lowest height point is 78 m and the highest is 121 m [87,88].

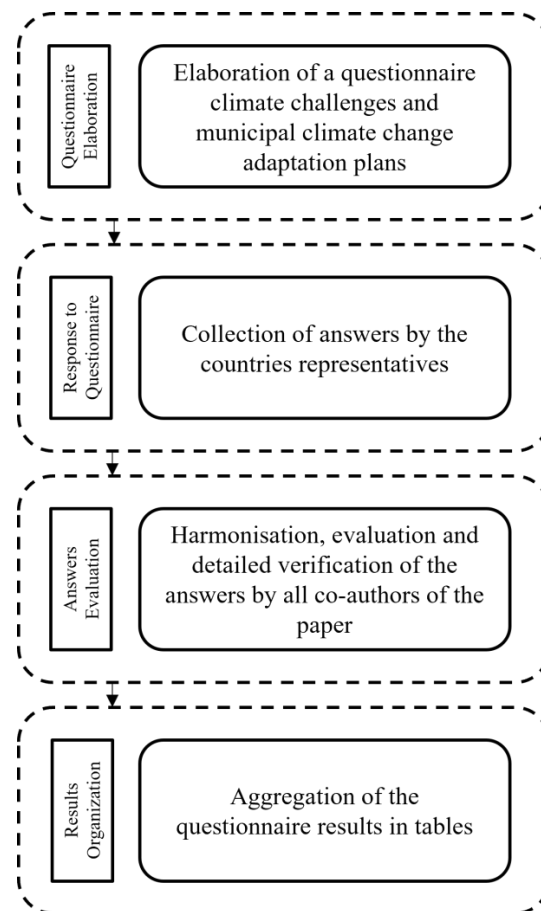
The three countries were the subject of earlier comparisons made by some of the authors in this team. This research is, therefore, a continuation of an earlier exercise. In addition, the selection has two additional advantages:

- It provides insight into how adaptation plans operate in countries with diverse climates and social attitudes towards climate challenges. It also allows for an examination of whether the level of climate risks and societal attitudes impact the use of such plans.
- Additionally, it offers the opportunity to investigate how adaptation plans work in different parts of Europe, considering their varying institutional characteristics.

To compare the institutional and spatial-climatic conditions in different countries, a specific method is needed. The authors draw on a tried and tested method that involves forming a team of authors from each country under scrutiny to collaboratively develop

a research questionnaire [13,89,90]. Questions are then answered by each author, who is knowledgeable about specific characteristics of her or his country, including both formal/legal aspects and practical considerations. The questions were formulated in such a way as to identify features of specific municipal climate change adaptation plans in a universal discussion. The questions formulated in the survey were preliminary questions. It was considered that there should, therefore, be a limited number of them. After the responses were received, the issues captured were clarified (within the framework of specific questions, specific to each country). The responses are subsequently reviewed for terminological consistency and presented in a uniform manner.

The four methodological steps appear in Figure 2. They are the following:



**Figure 2.** The four methodological steps.

- In the first step, the team created a questionnaire with common questions about climate challenges and municipal climate change plans (the question sheet can be found at the end of the article). It was based on insights gained from the literature and the previous studies conducted by the authors. The questions were directed to the co-authors—national experts in the field of urban planning and climate challenges in the countries studied (questionnaires were not directed to other people who were not co-authors of the article). The questions from the questionnaire were adapted to the research questions in the article.
- In a second step, representatives of each surveyed country or city answered all questions. It is important to note here that the authors specialize in the national climatic and spatial conditions of these countries.
- In the third step, the team compared responses from each country’s representatives and organized them into a table. The answers were carefully reviewed by all authors. This step was essential to ensure that the diverse land use planning legislation, policies, and

administrative structures across the three countries did not hinder the comparability of results. It also made the subsequent analysis clearer and more straightforward.

- In the final and fourth step, the results were aggregated in tabular form (see Tables 1–4). The development of these tables was crucial for organizing the information collected in the questionnaire, and it became the basis for preparing the results and writing the Discussion and Conclusions sections.

**Table 1.** Central-level documents identifying key climate challenges in Greece, Spain, and Poland [91–93].

Issues Requiring Action by Sectors	Greece	Spain	Poland
Air quality	No	No	No
Water resources	Yes	Yes	Yes
Coast/littoral	Yes	Yes	Yes
Mountain areas	No	No	Yes
Forestry	Yes	No	Yes
Forest fires	No	Yes	No
Biodiversity and ecosystems	Yes	Yes	Yes
Fishery and aquaculture	Yes	Yes	No
Desertification	No	Yes	No
Urban build (connection with climate adaptation)	Yes	No	Yes
Spatial planning	No	No	Yes
Health	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes
Tourism	Yes	Yes	No
Infrastructure and transportation	Yes	Yes	Yes
Mining	Yes	No	No
Energy	Yes	Yes	Yes
Insurance	Yes	No	No
Cultural heritage	Yes	Yes	No
Social attitudes	No	No	Yes
Innovation	No	No	Yes

It is worth noting that comparing institutional solutions from different countries, as carried out here, is a method used within the literature. However, simply comparing specific solutions and practices may not be the most effective approach. Hence, tables were carefully crafted through an in-depth analysis of national case studies and extensive discussions on their content. This meticulous process, involving researchers familiar with their systems, ensures thorough conclusions. While minor differences in the structure of acts across countries may lead to slight discrepancies in comparisons, these differences do not prevent meaningful research.

The research relates to the factual and legal situation in the surveyed countries as of 31 December 2023.

#### 4. Results

##### 4.1. Climate Challenges from the Perspective of the Central Documents of the Studied Countries

In Greece, the adaptation framework document for climate change is the Acts Greek National Adaptation Strategy to Climate Change [91], which provides detailed information

on current and future climate change in various sectors. It outlines Greece's strategic actions. It is complemented by The National Energy and Climate Plan, which is a strategic plan outlining a timeline for achieving energy and climate goals [94].

The National Adaptation Strategy to Climate Change is a modern, efficient, and growth-oriented adaptation strategy, following EU legislation and global experience, with its primary goals, guiding principles, and methods of execution. The key objectives identified in the National Adaptation Strategy to Climate Change are as follows: 1. Establish and enhance the (short-term and long-term) decision-making procedure regarding adaptation issues; 2. Link adaptation with promoting a sustainable growth model by implementing regional/local action plans; 3. Promote adaptation actions and policies in all sectors of the Greek economy, with emphasis on the most vulnerable ones; 4. Create a monitoring, evaluation, and update mechanism for adaptation actions and policies; 5. Build adaptation capacity and raise public awareness.

For its part, the National Energy and Climate Plan sets two key targets for 2030: reducing greenhouse gas emissions by more than 42%, compared to 1990 emissions, and by more than 56%, compared to 2005 emissions.

In Spain, the National Climate Change Adaptation Plan [92] was approved in 2020. It produces both evidence of climate problems and necessary actions. Due to the Spanish territorial model of a quasi-federal structure (State and Autonomous Communities), Adaptation Strategies to Climate Change have been approved in some regions (Autonomous Communities) (Basque Country, Catalonia, Valencia, Balearic Islands).

Finally, in Poland, the main relevant document is the Strategic Adaptation Plan for Sectors and Areas Vulnerable to Climate Change to 2020, with an Outlook to 2030 [93]. It identifies the main directions for adaptation. The main objective entails six specific aims: 1. Ensuring energy security and suitable environmental conditions; 2. Effective adaptation to climate change in rural areas; 3. Development of transportation under climate change conditions; 4. Ensuring sustainable regional and local development considering climate change; 5. Stimulating innovation conducive to climate change adaptation; 6. Shaping social attitudes conducive to climate change adaptation.

Table 1 summarizes the critical sectoral issues in these documents for all three countries. Note, however, that specific national aspects vary in prominence across the three countries. For example, the specific treatment of forest fires or desertification stands out in Spain. In Greece, the treatment of the insurance, mining, and fishing sectors stands out. Tourism receives special attention both in Greece and in Spain due to its essential economic contribution. For its part, Poland gives prominence to the treatment of mountain areas and spatial planning, as well as the role that social attitudes and innovation play in the adaptation to climate change. Nevertheless, in all three countries, water management, coastal biodiversity and ecosystems, health, energy, agriculture infrastructure, and transportation feature prominently within the adaptation plans.

#### *4.2. Legal Conditions for the Adoption and Content of Municipal Climate Change Adaptation Plans in the Countries Studied*

Nationally, guidelines for addressing climate issues show consistency across various countries, touching on similar themes. These include developing green infrastructure, mitigating urban heat impacts, and prioritizing environmental and nature conservation efforts. While some attention is given to adapting institutions to climate demands, this does not seem to be a primary focus. The suggestions found in national documents generally mirror those within the scientific literature, yet their actual efficacy remains uncertain.

However, it is important to note that a thorough diagnosis at the central spatial planning level is just a starting point for more refined studies. Climate challenges are diverse and complex. Meeting them successfully requires further actions and specific instruments. Municipal climate change adaptation plans are crucial in this respect.

In this sense, legal requirements in the three examples vary in how much they compel local authorities. Specifically, the creation of municipal adaptation plans, which are cru-

cial for carrying out climate change adaptation measures in different areas, ranges from mandatory to mere recommendations.

Hence, there is an obligation in Greece to adopt climate change adaptation plans at the regional level. There is no obligation (but an opportunity) to adopt adaptation plans at the municipal level. However, the legislation does not specify the content of such plans. Against this background, there are several municipal adaptation plans in Greece. Municipalities prepare them, but they are not legally binding acts. In addition, Sustainable Energy and Climate Action Plans have been enacted in several Greek cities. However, each municipality must prepare municipal emission reduction plans, set a net emission reduction target (at least 30% for 2030 compared to 2019), and prioritize the necessary measures and actions.

In Spain, on the other hand, state climate change regulation [92] only indicates the need to prepare climate change adaptation plans at the municipal level. However, they do not impose such an obligation. The only legal obligation is to designate low-carbon zones in municipalities with more than 50,000 residents. In some regions, regional climate change laws have been approved that require the preparation of local adaptation plans (Basque Country, Catalonia, Valencian Community). Because of that, municipal climate change adaptation plans have recently begun to be developed and approved. The approved plans include urban planning and urban design measures for adaptation to climate change that are barely developed. These plans are not legally binding unless the municipal plenary session approves them in the format of a municipal ordinance. Nevertheless, there have been no such cases in Spain thus far.

In the same sense, Polish regulations do not make adopting municipal climate change adaptation plans mandatory. These plans are, therefore, not legally binding. As of 2023, urban climate change adaptation plans have been developed in over 100 Polish cities. They are based on the provisions of Polish strategic documents and expert methodological guidelines.

Of course, it is important to focus on the broader regulatory context, despite the limited strength of climate change adaptation plans. In Greece, similar plans are required at the regional level, while, at the municipal level, more specific tools are commonly used. Conversely, Poland has a relatively high number of municipal climate change adaptation plans, which is good. However, there remains a systemic weakness in urban climate change adaptation plans in all three countries. Municipal climate change adaptation plans are crucial as they ensure a comprehensive approach to urban policies in addressing climate challenges. Other documents at higher levels or in specific sectors cannot replace the importance of municipal climate change adaptation plans.

To better grasp the details of certain municipal climate change adaptation plans discussed earlier, it is crucial to examine specific plans from all three countries. In this regard, a single urban climate change adaptation plan from a significant city in each country was chosen for analysis. Hence, the selected plans for analysis are from Athens, Warsaw, and Barcelona, as indicated in Table 2.

**Table 2.** Content of the urban climate change adaptation plan for each country's capital city [95–97].

City	Athens	Barcelona	Warsaw
Legal conditions	No obligation to adopt a plan at the municipal level. The provisions of the plan are not legally binding. Adopting climate change adaptation plans at the regional level is mandatory.	No obligation to adopt a plan at the municipal level. The plan's provisions are not legally binding. In some regions, regional climate change laws were passed that require the preparation of local adaptation plans (Basque Country, Catalonia, Valencian Community).	No obligation to adopt a plan at the municipal level. The provisions of the plan are not legally binding.

Table 2. Cont.

City	Athens	Barcelona	Warsaw
Key elements of the plan content	1. Energy production from renewable energy sources (RES) and retrofitting the built environment.	1. Reduce GHG emissions per capita by 45%, compared to 2005, through the following: <ul style="list-style-type: none"> <li>- Reduce mobility by private motor vehicles by 20%;</li> <li>- Multiply local solar generation by 5;</li> <li>- Energy rehabilitation of 20% of residential buildings that are older than 40 years.</li> </ul>	1. Strengthening the role of green and blue infrastructure.
	2. Accelerating the transition to sustainable and smart mobility.		2. Adaptation of the water management system, in particular the increase of biodiversity and retention of green areas.
	3. Urban revitalization incorporating green and blue infrastructure.		3. Increasing the resilience of technical infrastructures to extreme weather events and ensuring their operation and the supply of utilities to city dwellers in extreme weather events.
	4. Management and restoration of ecosystems and biodiversity.	2. Increase urban green by 1.6 square km, equivalent to 1 square m more green open spaces for each current inhabitant.	4. Taking measures to reduce the impact of extreme weather events on the health and life of inhabitants.
	5. Prevention and response to climate risks.	3. Obtain 100% net financing.	5. Adaptation of the social infrastructure.
	6. Circularity and sustainable water and waste management.	4. Achieve domestic drinking water consumption of less than 100 l/inhabitant/day.	
	7. Transition to a green and digital city.	5. Have zero energy poverty. 6. Subsidies for collaborative citizen projects.	
Main recommendations included in the plan	1. Installation of photovoltaic systems in municipal buildings.	1. Take care of everyone. Actions for older people in each neighborhood.	1. Controlling and reducing the urban heat island.
	2. Installation of photovoltaic systems on the roofs of Athens.	2. No cuts in drinking water. Guarantee water supply.	2. Ensuring ventilation of the city.
	3. Energy communities.	3. Prevent summer heat and implement climate shelters.	3. Creating and providing easy/universal access to cooling oases, such as suitable air-conditioned rooms or green spaces.
	4. Utilisation of biomass plant residues for energy production.	4. "Better than new buildings". Rehabilitation actions with energy and water efficiency criteria.	4. Creating and supporting infrastructure development that contributes to lowering the ambient temperature, such as developing green roofs and walls.
	5. Projects of an urgent nature and immediate implementation on existing infrastructures.	5. Recover the rooftops. Green roofs.	5. Protecting existing green areas and increasing their proportion.
	6. Flood road protection projects	6. More green open spaces. Expand green areas.	6. Increasing the proportion of biologically active areas by reducing impervious surfaces.
	7. Repair, maintenance, and cleaning of manholes and storm drains.	7. "Not a drop wasted". Circular water economy.	7. Protection, modernization, and construction of hydro-technical and water reclamation facilities.
	8. Separation of rain and wastewater into separate sewer systems.	8. Renewables in public space.	8. Reconstruction of critical public infrastructure located in floodplains.
	9. Citizen information and vigilance actions, as well as heat preparedness actions.	9. "Move well". Sustainable urban mobility with zero-emission vehicles.	9. Creation of water retention systems in the city.
	10. Redesign actions for a cooler city.	10. "Conserve the sea". Coastal and sea protection actions.	10. Introducing solutions aimed at increasing the energy independence of the city, including expanding the share of energy from renewable sources.
	11. New educational programs for students.	11. "Virtuous circle". The circular economy urban plan.	11. Cabling of overhead grids in areas particularly exposed to strong winds.
	12. Adopt your city/adopt a newly planted tree.	12. Responsible consumption. 13. Zero waste. Efficiency in the collection of urban waste. 14. Food sovereignty. 15. Cultural action for climate. 16. Promote climate cooperation with other cities. 17. Articulate effective governance mechanisms between administrations to reduce the impact of climate change.	12. A systemic approach to the creation of green and blue infrastructure elements. 13. The creation of systems to protect existing green infrastructure areas.

The main challenges faced by all three cities are extensively outlined for Athens (Table 2). Key thematic areas have been identified, with detailed objectives that align with national guidelines and literature insights. Each area of interest is underpinned by thorough reflection, helping readers understand how specific measures correspond to general requirements. For instance, the topic of “energy production from renewable sources and upgrading building energy efficiency” includes tasks like retrofitting existing buildings, using renewable energy sources, and improving street lighting. Simply looking at these plans is not enough: delving into detailed guidelines, often tailored to specific city areas, is crucial to achieving the desired climate change adaptation by municipalities, as illustrated in Table 3.

**Table 3.** Climate challenges and spatial planning [98–100].

Greece	Spain	Poland
<p>Local Urban Plans (LUPs) and Special Urban Plans (SUPs). The Local Urban Plans (L. 4258/2014, art. 2):</p> <p>(a) Are harmonized with the Regional Spatial Planning and Sustainable Development Frameworks guidelines.</p> <p>(b) In the residential areas of the LUPs, the permitted categories of land use, density, building coefficient, and other building conditions or restrictions are defined, as well as the general assessment of the needs of each urban unit in terms of public spaces, public utilities, and infrastructure, as well as networks in general.</p> <p>(c) The LUPs include protection areas subject to special legal protection regimes, such as forests and woodlands, coasts, beaches, rivers, lakes, streams, and land use control areas where special restrictions are set. The LUPs delimit existing watercourses (L. 4258/2014, art. 2).</p> <p>The Special Urban Plans:</p> <p>(a) concerns the spatial organization and development of areas, irrespective of their administrative boundaries, which may serve as receptors for projects, works, and programs of supra-local scale or strategic importance or require special regulation of land use and other development conditions.</p> <p>(b) can be prepared for protection or mitigation programs against the consequences of natural disasters and in case of the need for rapid completion of first-level urban planning by the state due to critical spatial problems that require an immediate response or the prevention of <i>fait accompli</i> situations due to lack or inadequacy of urban planning.</p>	<p>The state Climate Change Law (2021) includes the obligation to incorporate climate change in regional and urban planning and management, with the following principles:</p> <p>(a) Considering risks derived from climate change, in accordance with related policies.</p> <p>(b) Incorporating measures in planning and management instruments to support gradual adaptation and resilience to climate change.</p> <p>(c) Updating building and transport infrastructure design guidelines and calculations to align with climate change impacts while gradually adapting existing ones to reduce emissions.</p> <p>(d) Considering the mitigation of the “urban heat island” effect in the design, renovation, and management processes, and preventing the dispersion of excess energy from urban infrastructures into the atmosphere.</p> <p>For its part, it is necessary to consider the principle of prevention of natural risks and severe accidents in the planning of land uses. Risks derived from climate change will also be included:</p> <p>(a) Risks from marine impacts, coastal flooding, and rising sea levels.</p> <p>(b) Risks from extreme weather events on essential public infrastructure and services, such as water, electricity, or emergency services.</p> <p>(c) Risks of mortality and morbidity derived from high temperatures, particularly those that affect vulnerable populations.</p> <p>(d) Risks associated with the loss of ecosystems and biodiversity, particularly the deterioration or loss of essential ecosystem goods, functions, and services.</p> <p>(e) Fire risks, with particular attention to risks in the urban–forest interface and between infrastructure and forest areas.</p>	<p>There is a lack of spatial planning instruments that can be directly linked to the response to climate challenges. There is a lack of clear ranking of spatial planning objectives in the context of climate challenges. It is only possible to indicate that some parts of the spatial planning instruments can be linked to climate challenges. This is framed chaotically and haphazardly (especially from the perspective of climate challenges). Examples include:</p> <p>(a) The requirement to specify biologically active areas in spatial plans for plots intended for development;</p> <p>(b) The subtle promotion of the inclusion of green areas in urban spatial plans.</p>

The Barcelona plan follows a similar structure. It includes overarching guidelines closely aligned with national directives, as well as specific indicators of change. These detailed indicators allow for regular monitoring of how well the plan’s guidelines are considered in planning practices.

The guidelines and goals formulated in the Warsaw plan are somewhat less systematic and detailed. Nonetheless, they define vital recommendations in a very similar manner. To a more limited extent, the detailed application of these guidelines refers to individual areas.

The provisions of climate change adaptation plans address key climate challenges rather comprehensively in all three cities. The important question is, however, how their implementation can be verified and how provisions relate to spatial planning.

In Athens, Key Performance Indicators (KPIs) have been developed for each action in the Climate Action Plan to monitor progress on climate change annually [95]. Barcelona has established five types of indicators to monitor the 18 strategic actions of the Barcelona Climate 2030 Plan (impact indicators, performance indicators, resource indicators, environment indicators, perception indicators, and execution indicators) [96]. Warsaw has specific result indicators matched to individual measures, thereby ensuring accountability [97].

In Athens and Warsaw, plans assess the achievement of objectives, sometimes focusing on specific indicators. However, municipal climate change adaptation plans are not legally binding; therefore, non-compliance with criteria or guidelines does not result in adverse effects. The Barcelona plan includes a comprehensive evaluation based on very detailed guidelines, with a thorough analysis of changes in each strategic action. Figure 3 shows the organisation in the 'superblocks' of Barcelona and an example of action in the urban sector of L'Eixample.



while Warsaw’s plan does address key elements, such as protecting green open spaces and integrating climate considerations into planning documents, it lacks the same precision seen in Barcelona.

Nevertheless, the need for flexible planning does not feature prominently in the three case studies. In this sense, municipal climate change adaptation plans could benefit from incorporating the legal agility seen in municipal planning documents (Table 4).

**Table 4.** Spatial dimension of the analyzed climate change adaptation plans [95–97].

City	Athens	Barcelona	Warsaw
Key spatial recommendations in climate change adaptation plans	Installation of photovoltaic systems in municipal buildings. Installation of photovoltaic systems on the roofs of Athens. Mapping of the street lighting network to replace all the lamps. Upgrading and widening sidewalks, light traffic roads, and walkways. Expansion of the bicycle paths network. Restorations and renovations of public areas. Pocket parks. Establishment and acquisition of green spaces. Building shell planting, green roofs, walls, and stops. Green roads, corridors, and routes.	Rehabilitation of homes for vulnerable people. Create new green areas: “Barcelona, city of shadow”. Create “climate shelters”. Regulate pavements and roofs to increase the albedo. Adapt current urban planning regulations to climate change. Use draining pavements. Creation of “superblocks” throughout the city, to reduce vehicle circulation and recover the streets for citizens.	Implementation of sustainable development. Protection of green spaces. Management of rainwater in the rainfall area. Considering the heat island in planning documents, including monitoring and causal factors. Considering potential flooding and flood risk analyses in planning documents.

Implementing climate guidelines through spatial planning instruments is essential, regardless of the content of climate change adaptation plans. The three countries demonstrate various approaches to achieving this objective, as shown in Table 3.

Table 3 illustrates how the climate dimension is integrated into the spatial planning system of the three countries, focusing on legal and institutional aspects. The table highlights how spatial planning law, enacted centrally, enables spatial planning instruments to address climate challenges in each country’s unique way. Note, however, that each direction points to a specific adaptation in national law.

Poland shows the least integration between the two spheres. Spain has established guidelines and priorities at the statutory level, allowing for more extensive land-use restrictions at the municipal level. Noteworthy here is the introduction of new calculation and design instructions for transport infrastructure buildings (primarily related to changes in building law). Greece distinguishes between two crucial instruments: Special Urban Plans and Local Urban Plans. Special Urban Plans complement Local Urban Plans, and, thereby, play a unique role:

- They refer to particularly important areas (irrespective of administrative boundaries), which require special regulations;
- Their regulations are implemented swiftly;
- Previously adopted Local Urban Plans need to be adapted to their content.

#### 4.4. Effectiveness of Municipal Climate Change Adaptation Plans

An attempt was also made to verify whether the provisions of municipal climate change adaptation plans translate into concrete results. However, this analysis is supplementary (a bit beyond the institutional-legal sphere) and requires some caveats to be made.

Table 5 attempts to show the effects of the climate change adaptation plans studied. It should be emphasized right away that the effectiveness of the specific solutions can be considered in different ways. The specific effects are not only due to specific provisions but rather to broader, varied actions—both by municipal authorities and other stakeholders. Nevertheless, with this caveat, it is possible to identify key effects. Table 5 shows that the most effects related to the implementation of the plan’s provisions can be identified in Barcelona. In contrast, there are no serious effects in Warsaw.

**Table 5.** Effectiveness of applied solutions in climate change adaptation plans—selected aspects. Based on own elaboration.

Greece	Spain	Poland
<p>Improve the Municipality’s ability to address the increasing urban temperatures.</p> <p>Transform the built environment to establish neighborhoods that are more livable, appealing, and sustainable.</p> <p>Increase in RES share in electricity consumption.</p> <p>Sustainable and smart mobility.</p>	<p>Approval of urban plans for the creation of urban superblocks, which already has concrete examples in the L’Eixample àrea.</p> <p>Since 2019, creation of a network of 300 climate shelters in public buildings in the city.</p> <p>Approval of the expansion of the Prat de Llobregat desalination plant with the new floating desalination plant in the port of Barcelona, which will increase the desalination capacity of the first one by 14 hm<sup>3</sup>/year (60 hm<sup>3</sup>/year). This guarantees 40% of Barcelona’s urban supply in the event that a new drought could endanger the supply from the water transfer from the Ter River.</p> <p>In 2023, the construction of 31 new rainwater tanks has been approved to store rainwater and reduce the risk of flooding in the urban area.</p>	<p>No significant effects. The plans are a postulatory instrument without broader translation into concrete spatial effects.</p>

## 5. Discussion

### 5.1. Key Topics Addressed in the Article

These results provide input for a discussion on the role and tasks of climate change adaptation plans as relevant instruments for implementing climate tasks. The following issues should be noted here:

- Considering supra-local guidelines, particularly those outlined in national strategic documents;
- The legal features of climate change adaptation plans;
- The way and extent to which climate change adaptation plans relate to spatial planning;
- Verifying the potential and actual implementation of climate change adaptation plan provisions, as well as evaluating the implementation process.

Against this background, the study focused on institutional objectives concerning the adoption and implementation of municipal climate change adaptation plans. It aimed to provide a detailed overview of the institutional context surrounding these instruments in the three countries studied. The research questions guided the content presented in the four tables.

### 5.2. Linking the Content of Surveyed Climate Change Adaptation Plans to Climate Challenges and a Characterization of the Legal Considerations for the Plans

The first research question aimed to evaluate how well climate change adaptation plans align with broader studies of climate challenges. The alignment varies among the three countries studied. Generally, national-level guidance on climate challenges does not cause controversy. Table 1 supports this observation. National strategic documents typically base their assessment of challenges on scientific literature. However, they may not propose specific radical solutions, necessary from a climate perspective but potentially

challenging from a societal standpoint. Local and regional levels may be better positioned to implement such solutions. This underscores the significance of climate change adaptation plans in addressing these challenges effectively. Three geographically diverse European countries and cities were compared. Two of the cities analyzed (Athens and Barcelona) have a Mediterranean climate. They are feeling the intensive (for Europe) climate changes. Warsaw, located in Central and Eastern Europe, also feels climate change, but to a decidedly lesser degree. It seems that this differentiation determines the different meanings of the content of the city's climate change adaptation plans (economic characteristics and selected features of the physical geography of the compared cities are far less important in this regard). In Poland, the approach of public authorities to responding to climate challenges is still very moderate. Some political forces even deny the existence of climate change. This makes it difficult to undertake more decisive changes. It is also for this reason that the content of the municipal plan for adaptation to climate change in Warsaw, compared to the plans of Athens and Barcelona, is so vague (and, consequently, ineffective).

The second research question focused on exploring the connections between legal and institutional conditions and the effectiveness of climate change adaptation plans. The study involved verifying the legal basis and detailed content of these plans. In the case studies examined, climate change adaptation plans are typically not legally binding, unlike spatial plans at the local level. Public authorities in cities have no obligation to implement them. These findings were primarily drawn from Table 2, which outlines the legal framework related to municipal adaptation plans. This raises questions about the role of regulations in development policy. It is not always the mandatory nature or level of detail in regulations that ensures desired outcomes; instead, the application of good practices is key. The law can support these processes.

The results in Table 2 offer a foundation for contemplating the optimal role of law in urban development processes. It is evident that detailed guidelines, even if formulated at the municipal level, may not always lead to effective outcomes. Therefore, the relatively weak formal-legal status of plans highlighted in Table 2 should not necessarily be viewed negatively. On the other hand, the mere widespread adoption of climate change adaptation plans does not guarantee positive results, as demonstrated by the cases of Spain and Poland. Climate change adaptation plans need to encompass a comprehensive strategic dimension [40,105]. They should serve as strategic initiatives that set the course for change [42]. However, strategic planning alone is not enough. It is essential to assess the potential implementation of their provisions. In this regard, special attention should be given to:

- The details of provisions: Plans cannot be too general and fragmented, like in Warsaw (see Table 2). On the one hand, they should set general objectives (linked to the national level); however, these objectives must be translated into detailed, specific guidelines (something done well in Athens). It is also worth highlighting the example of Barcelona, where the guideline plan is formulated to lend itself to rapid evaluation.
- The mechanisms for evaluating provisions: Here, defining them as an obligation for public authorities (public participation included) provides an opportunity for more effective implementation. The literature underscores the importance of ongoing evaluation when implementing climate change adaptation plans. The examples of Barcelona and Athens (see Table 2) validate the relevance of this requirement in certain planning contexts. Conversely, the limited evaluation processes in Warsaw highlight that overlooking this aspect can lead to substantial difficulties in implementing climate change adaptation strategies in cities.
- The link between climate change adaptation plans and spatial planning: A major prerequisite for successfully implementing climate change adaptation plans is aligning spatial planning instruments with them. This issue is associated with the third research question, which examines how climate change adaptation objectives intersect with urban spatial policies. This analysis is detailed in Tables 3 and 4, which relate climate objectives to urban spatial policies. Countries like Greece and Spain offer two possible approaches: integrating climate guidelines into existing statutory instruments or

developing dedicated ‘climate-spatial’ instruments for quicker and more adaptable responses. Adaptation plans should also incorporate specific directives for spatial planning, with the Barcelona plan serving as a notable illustration of this integration.

These conclusions can be linked to discussions found in the literature. Within this context, strategic planning plays a significant role. It is essential to craft strategic planning measures in a way that ensures their implementation and retains their strategic character [106–108]. When it comes to strategic planning addressing climate challenges, a comprehensive, cross-sectoral approach to policymaking is vital [36], alongside the need to verify the application of climate requirements [51]. Therefore, these plans should be outlined in a more detailed manner, focusing on specific objectives derived directly from overarching goals, rather than intricate provisions. However, it is important to note that the role of climate change adaptation plans should not be reduced to a meticulous verification of detailed demands [52]. Such an approach would risk diluting the strategic essence of these planning acts.

### 5.3. *Links between Climate Change Adaptation Plans and Spatial Planning Instruments*

Building on the previous discussion, it is worth noting that climate change adaptation plans possess unique characteristics compared to other strategic documents. These plans emphasize the importance of addressing climate issues by conducting thorough experience analyses and articulating aspirations for integrating development policies. However, the case of Poland highlights the significance of not overlooking the practical implementation of planning provisions into tangible actions.

Climate change adaptation plans serve as documents that blend scientific knowledge with practical insights [109]. The information presented in Table 2 illustrates this integration. By examining the table, one can observe how expert knowledge is intertwined with guidelines outlined in climate change adaptation plans across different countries. The scientific literature offers a rich array of insights into climate risks and potential solutions. Although there are global discussions on climate challenges, individual countries also tailor specific requirements and guidelines for their adaptation plans. These plans, broader in scope than spatial plans, are better equipped to incorporate a variety of scientific recommendations, which could be more difficult to include in spatial planning documents.

Against this background, the connection between climate change adaptation plans and spatial planning is a crucial aspect to consider. Both areas require institutional coordination. Additionally, urban development, including site selection for construction, must be harmonized with climate challenges. Addressing climate needs involves effectively reducing the built-up area per person [110]. From a spatial policy viewpoint, this should encourage compact urban growth and the preservation of environmentally significant areas. Barcelona’s initiatives in this regard stand out as exemplary solutions.

### 5.4. *Limitations of the Study*

Please note that this piece of research has limitations due to focusing on three European countries, each with unique characteristics. In-depth comparisons require specific analyses, going beyond a simple contrast. The authors’ focus on these three countries is understandable given the complexity of their systems. Legal variations in spatial planning systems add another layer of complexity, making universal conclusions challenging.

Despite these limitations, the topic of climate change adaptation is worth further exploration, especially for the following:

- Verifying features of climate change adaptation plans in other countries. This comparison seems justified, and the article highlights critical criteria in this respect;
- Considering the possibility of compiling and comparing other acts concerning climate in individual countries. This comparison should also include the regional perspective;
- Identifying “climate-spatial” demands (the example of Barcelona seems most inspiring in this respect) and developing a comprehensive European catalog.

## 6. Conclusions

The article attempts to identify key institutional features of urban climate change adaptation plans in three disparate countries (and cities). Directionally, it can be said that the goals associated with the adoption of the analyzed plans are similar in all three cases. What is different, however, is the detailed way in which the provisions of the plans are framed and how they are translated into the sphere of urban planning. In order to verify the present issues in detail, a comparative analysis was used, with the participation of experts (co-authors) from each studied country.

Three research questions were formulated. The comparative analyses lead to the conclusion that, in each case, the content of the studied urban climate change adaptation plans is related to the diagnosed (in national documents and national literature) climate goals. The problem, however, is the detailed formulation of specific actions in the plans. The example of Poland shows that specific provisions can be formulated in general terms, with little possibility of accounting for effects. The examples of Greece and Spain, on the other hand, show that, in municipal climate change adaptation plans, it is possible to relate precise demands to specific parts of the city and to provide a viable process for evaluating the effects implemented by the plans. These findings also contribute to answering the second research question, namely, on the role of law in shaping urban climate change adaptation plans. These plans do not have to be binding acts (for example, for property owners). Nevertheless, it is the legal regulations that should ensure that the provisions of the plans can be realistically enforced. It is also important to translate the content of climate change adaptation plans into the content of spatial planning instruments (the third research question). The optimal solution in this regard is to align the content of spatial planning instruments with climate challenges, climate terminology, and climate goals. It is often helpful to develop separate (implementing these goals) spatial planning instruments. Based on the research conducted, the following can also be pointed out:

- Climate change adaptation plans in Athens and Barcelona are prepared more ambitiously and in a more systemically thought-out manner than the plan for Warsaw. However, in Poland, the government is currently considering changing the regulations on climate change adaptation plans (and taking into account solutions from other countries);
- When translating the content of adaptation plans into the spatial sphere, the solutions are more in-depth in the Spanish and Greek systems (which, of course, does not exclude the possibility of further partial revisions).

This article provides a contribution that can be used for further discussion on the integration of the sphere related to responses to climate challenges with the sphere of spatial planning. Framing this topic in the context of international comparisons is a difficult challenge due to the serious diversity of national legal orders (including across Europe) and the different social and climatic specificities of individual countries. However, the article proposes how these comparisons can be implemented.

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