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Italy vs. Poland: A Comparative Analysis of Regional Planning System Attitudes toward Adaptation to Climate Changes and Green Infrastructures

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Abstract: European spatial planners deal with two major concerns: adaptation to climate changes (ACC) and the design and management of green infrastructures (GIs). ACC calls for the renewal of spatial planning with constant appeals to the need to adequately prepare for extreme climate events. GIs deliver ecosystem services (ES), which consist of beneficial functions to living beings in terms of, for example, helping people adapt to climate change. An effective implementation of adaptation measures at the regional and sub-regional scale is based on an efficient and prompt spatial planning system and GIs management. In this paper, we aim at comparing the attitudes of Italian and Polish spatial planning systems with respect to the integration of concepts related to ACC and GIs. We describe commonalities and differences between the two spatial planning frameworks by scrutinizing regional plans adopted in Sardinia (Italy) and Wielkopolska (Poland). We found out a scarce consideration of both ACC and GIs planning and management. The findings suggest that the regional spatial planning tools need to be updated to be fully satisfactory in terms of ACC and GIs concepts.

Keywords: planning systems; spatial planning; regional plans; climate resilience; green infrastructures; assessment criteria

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1. Introduction

The European Union (EU) has emphasized the need to adapt to climate change by adopting in 2013—and updating in 2021—the EU strategy (EU strategy) on adaptation to climate change (ACC) [1,2]. While there are many definitions of ACC, here we mean ACC as the "adjustment of human and natural systems to climatic actual or expected events, in order to minimize damage or maximize benefit" (after [3,4]). The EU strategy aims at making the European member states more climate-resilient, remarks on the need to adopt adaptation measures from national to regional levels, and stresses the urgency to "achieve coordination and coherence at the various levels of planning and management through national adaptation strategies" [2]. In 2013, the Polish government published the "Strategic adaptation plan for sectors and areas sensitive to climate changes in Poland by 2020, with an outlook by 2030" (SPA 2020, developed as a part of the Klimada Project [5]). The SPA 2020 was the first document dealing with adaptation to climate changes in Poland. In 2015, the Italian Ministry of the Environment and Protection of Land and Sea adopted the National Climate Change Adaptation Strategy [6]. Italy is also developing a National Climate Change Adaptation Plan (December 2022, latest update; [7]).

According to the EU strategy, the Mediterranean basin is vulnerable to climate change [2]. In this regard, in February 2019, the Autonomous Region of Sardinia adopted the Regional Strategy for Adaptation to Climate Change (RSACC) with the purpose of paving the way for increasing the climate resilience of the region to extreme weather

events [8]. Regional planning should be consistent with the RSACC: thus, spatial planning is crucial for the promotion of adaptation approaches from regional to local scale. Polish regional strategic documents are being drawn up to adapt cities to the climate change presented in global and regional climate scenarios. However, these documents take only a limited account of current knowledge on assumed climate change or the nature of this change for the quality of human life.

Spatial planning (SP) has been defined in a variety of ways. In this paper, we follow Davoudi's definition of SP: "actions and interventions that are based on 'critical thinking about space and place' [that] involve not only legislative and regulatory frameworks for the development and use of land, but also the institutional and social resources through which such frameworks are implemented, challenged and transformed" [9]. According to Busayo et al., lately, "spatial planning laws on the global scene have metamorphosed to cover broader areas and facets that call for the integration of planning systems into diverse sectors for addressing societal issues including climate change adaptation" [10]. Spatial planning is instrumental in fostering the integration of adaptation goals according to different institutional hierarchical levels to address budgetary constraints and develop synergies [4,11]. Developing a strategy at the regional and local level is of fundamental importance and is extremely difficult not only in Poland [12]. Regional planning tools are usually drafted through multi-actor collaboration and could be frameworks for defining successful adaptation measures sub-regionally, for example through municipal master plans [4]. According to Ledda et al. [4], "the regional plans are relevant to local planning and might be key to link national and regional adaptation principia and strategies to local adaptation measures". However, we found a certain lack of studies—a research gap—that deal with adaptation to climate change in regional spatial plans (or regional plans strictly related to spatial planning issues) in Italy and Poland and that consider results obtained from the comparative approach of two European regions.

According to Cortinovis and Geneletti (2018) and Lai et al. (2019) [13,14], the integration of green areas (including green infrastructures) in urban planning processes can contribute to provide ecosystem services and benefits for humankind, including adaptation to climate change solutions [15]. Therefore, a proper understanding of the usefulness of green infrastructures for enhancing environmental quality is both theoretically and practically relevant to local urban planners [16]. In this paper, we mean Green Infrastructure (GI) as "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings" [17]. Scientific literature has scarcely addressed systematically the inclusion of GI in regional planning tools in Italy and Poland. De Montis et al. (2022) [18] state that the "scrutiny of green infrastructures related concepts integration patterns in planning documents would lead to a better understanding of the strengths and weaknesses of planning frameworks".

Thus, this study aims at filling two research gaps via two research questions (RQs) by scrutinizing a set of regional plans adopted in Sardinia (Italy) and Wielkopolska (Poland): (i) How do Sardinia and Wielkopolska consider adaptation to climate change and GI in regional spatial planning tools or regional plans closely related to spatial planning issues (RQ1)? Can the organization of the spatial planning system of Italy and Poland contribute at the integration of adaptation to climate change and GI in regional (and subregional) spatial planning tools (RQ2)?

RQ1 aims at investigating if—and to what extent—key concepts of adaptation to climate change and GI characterized the regional planning process and pointing out the main strengths and weaknesses of the tools. RQ2 has the purpose of stressing if and how the current organization of the spatial planning system of both the states has potential to ease the integration of adaptation issues and ecosystem services—delivered by GI—into practice.

The manuscript unfolds as follows. In Section 2, we provide the reader with an overview on the main elements that characterize the planning systems of Italy and Poland. In Section 3, we report on a brief literature review concerning spatial planning and ACC and spatial planning and GI. In Section 4, we exemplify the methodological approach. In Sections 5 and 6, we illustrate and discuss the results (Section 5) and, respectively, summarize the concluding remarks (Section 6).

2. Spatial Planning in Italy and Poland

Italy, in southern Europe (Figure 1), is a democratic republic, which belongs to the European Union. The state extends over a surface area of 302,073 square kilometers and is characterized by a predominantly hilly area (41.6% of the total area), while mountain and plains cover about 175,202 square kilometers (respectively, 35% and 23.2% of the total area; Italian National Institute of Statistics, 2014 [19]). The Italian peninsula consists of 20 administrative regions, which host about 60 million residents (Italian National Institute of Statistics, 2021 [20]) in 7904 municipalities (Italian National Institute of Statistics, 2022 [21]). The municipalities are clustered in—and administered by—80 Provinces, 2 Autonomous Provinces, 14 Metropolitan Cities, and 6 Free Municipal Consortia (Italian Republic, 2022 [22]).

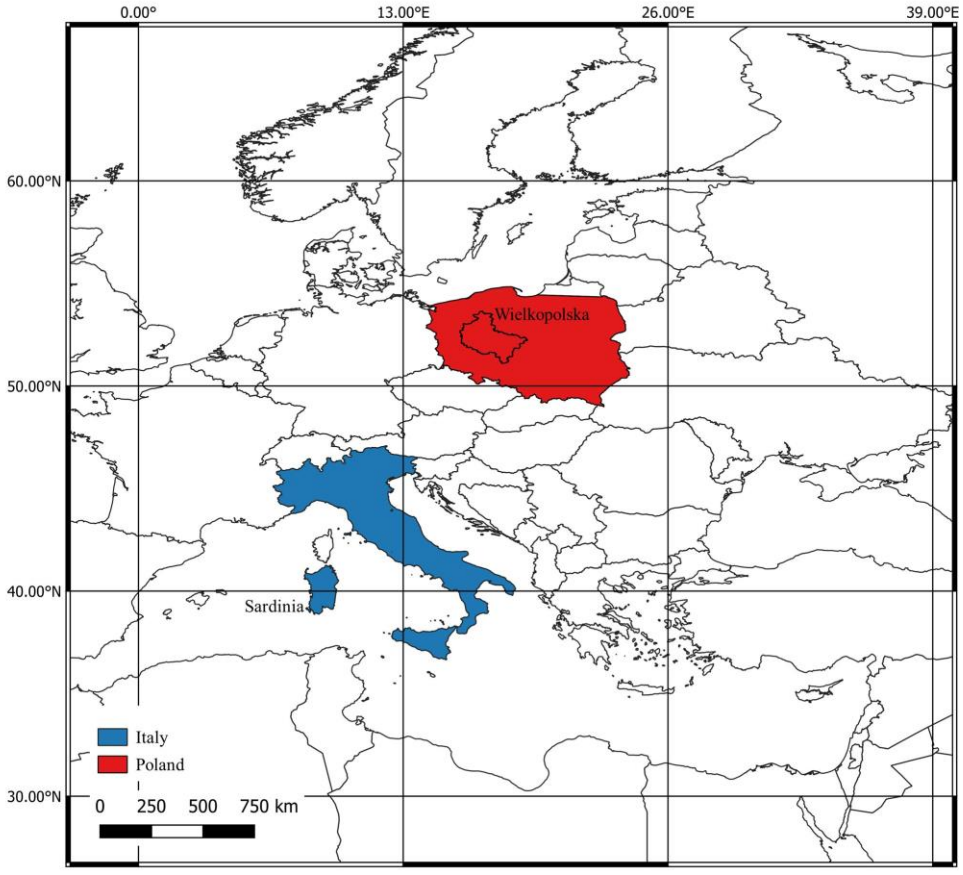

Figure 1. Geographical context.

Italy approved laws with the aim of regulating human behavior in a meticulous way (Italian Republic, [23–27]). We can recognize a juridical tradition of Italian law, which assumes that a correct behavior must constantly be referred to a written normative source. The tradition of Italian law has determined a planning system largely based on the so-called "command and control" scheme, according to which the regulatory apparatus requires a top–down approach, i.e., the public administrations promote territorial transformations

that are conformed to certain characteristics and check that these transformations take place in accordance with the plans [28].

The Italian urban planning law [23] could be considered as one of the most innovative when it was enacted "as it introduced multi-level planning and urban development plans extended to entire municipal territories and limited the building activities of municipalities lacking urban development plans" [29]. The Italian urban planning law of 1942 was never repealed or replaced and is still in force. In the 1970s, the legislative activities concerning urban planning were delegated to the 20 administrative regions and were characterized by weak strategic regulation and strong heterogeneity [29–31], "thus easing forms of control and increasingly delegating decision-making to [also very small and demographically irrelevant] municipalities" [30].

While the urban planning law of 1942 [23] focused on the urban development, in the last decades in Italy, the processes of urban growth have undergone a drastic setback, and it has been understood that beyond certain limits the urban sprawl has negative effects for the economy and for the real estate market [32].

The plans can be classified by the function they perform or by their scale (national, regional, sub-regional, municipal scale). Table 1 summarizes the main spatial planning activities of Regions, Provinces, Metropolitan Cities, and municipalities according to Petroncelli [32].

Table 1. Main spatial planning activities of Regions, Provinces, Metropolitan Cities, and municipalities (after Petroncelli [32]).

Body	Spatial Planning Activities	Main Spatial Planning Tool	Type
Region	Urban planning, Social and territorial planning, Guidelines for local authorities, . . .	Regional landscape or territorial plan	Strategic
Province	Proposal of provincial multiannual programs of general and sectoral type, Coordination of municipal planning activities, Drafting and adoption of the spatial coordination plan, . . .	Provincial spatial coordination plan	Strategic
Metropolitan City	Spatial planning of the metropolitan area	Metropolitan plan	Strategic
Municipality	Local urban planning, Adoption of the municipal master plan, . . .	Municipal master plan	Operational

According to De Montis [28], the coordination plans (e.g., the provincial spatial coordination plans) refer to large portions of the territory (at least inter-municipal scale) and define a framework for the territorial transformations; the operational plans (e.g., the municipal master plans) are approved in accordance with the coordination plans usually at the municipal level and affect the local administrative area; the executive plans concern the implementation of measures—included in the operational plans—in practice.

Italy acknowledges four administrative levels: state, region, province, and municipality (Figure 2, after [33]; Larsson [34]). National sector plans adopted at the state level are very rare, as the "planning competences have been transferred to the lower-level administrative bodies" [4]. Regions, provinces, and municipalities adopt a plurality of instruments—coordination, operational regulation, and implementation instruments—to regulate their own development. Usually, regional and provincial governments draw up instruments (e.g., coordinator territorial plans) aimed at regulating the development of large areas through general provisions, while municipalities regulate changes to their land through municipal master plans [35–38].

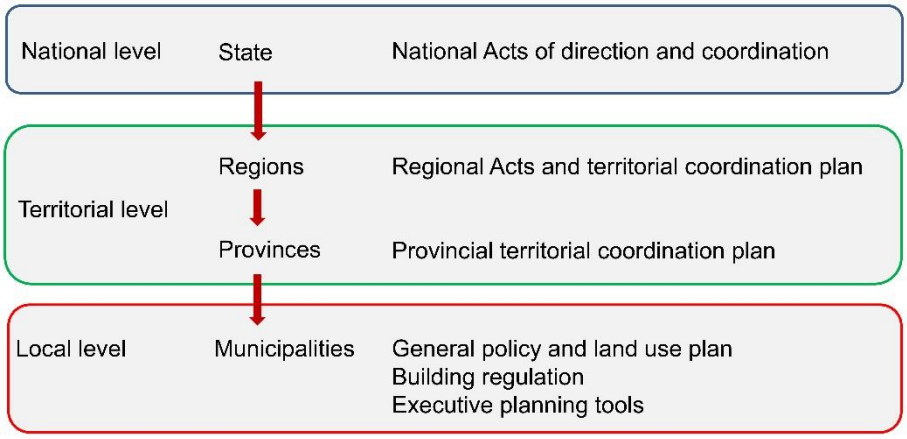

Figure 2. Organization of spatial planning system in Italy. Based on—and modified from—Bragagnolo et al. [33].

Poland, officially Republic of Poland, is a country in central Europe (Figure 1) and since 2004 is a member state of the EU. Poland covers an area of 312,696 km^2 and is the fifth-most populous member state with a population of over 38 million. The implementation of the spatial policy in Poland obeys the Spatial Planning and Development Act (SPDA) approved in 2003. The SPDA regulates the spatial planning system in Poland, including the development of spatial policies and spatial plans (concepts, plans, studies) and attributed different powers to the administrative tiers of government [39]. The Polish spatial planning and management system has changed a lot over the last 30 years. The most relevant transition occurred after the fall of socialism [40]. During the socialist era, planning and decision making were centralized so that local authorities had no influence and were mere executors of spatial transformations in their own area. Between 1989 and 2003, the Polish Government established and implemented a roadmap for building a new spatial planning and management system. Similarly, other central and eastern European countries restructured their spatial planning and management system. For most countries, this restructuration has been steered and eased by the process of adhesion to the European Union [41–43].

According to the Polish Constitution, the territorial system of the Republic of Poland ensures the decentralization of public power [39]. Governmental bodies operate in four hierarchical tiers (Figure 3): the state, at the national level; sixteen regions (Voivodeship), at the regional level; 379 provinces (Powiat), at the intermediate level; and 2477 municipalities (Gmina), at the local level. National, regional, and local level administrations are committed to land use planning. The national government steers spatial planning, according to the Long-term National Development Concept (Poland 2030), which has integrated and substituted the National Spatial Development Concept. These documents set out the conceptual framework and address the development of the whole country, by organizing the environmental and landscape protection system. Voivodeships play a limited role in spatial planning through the Regional Spatial Plans together with spatial development plans for urban functional areas. Powiats have only minor functions related to planning. The main actors in land-use planning are the municipalities, which elaborate mandatory studies on local planning scenarios for the whole communal area and the Local Spatial Development Plan for part of the community, the only legally binding zoning plan. The disadvantage of local plans is that they are recommended but not mandatory. According to a hierarchical scheme set out by the SPDA, the local plan is drafted in conformance with the spatial development plan of a voivodeship, which obeys to the National Spatial Development Concept and Long-term National Development Strategy (Figure 3).

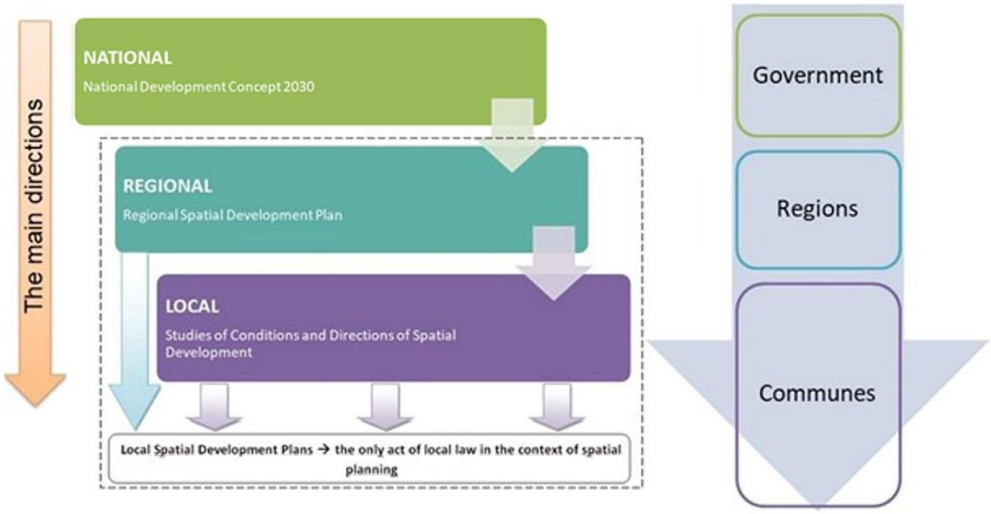

Figure 3. Organization of spatial planning system in Poland, according to the Spatial Planning and Development Act (SPDA) issued on 27 March 2003.

3. Literature Overview

The scientific cornerstones of this paper consist of the integration in spatial planning of adaptation to climate change and green infrastructures. We report on the literature review in the following two subsections.

3.1. Adaptation to Climate Change and Spatial Planning

Multi-level and multisectoral approaches can support effective adaptation to climate change [44,45]. However, in human—ecological systems, there is no guarantee that multi-level governance will be effective [4,46]. ACC can be addressed at supranational, national, regional, and sub-regional (local) scale, although scholars have been focused more on national and local than the regional scale [4,47]. ACC involves cascading decisions in which both public agencies and individuals act [48]. According to Lukat et al. [11], the connection between ACC and SP can promote the consideration and introduction of climate change adaptation objectives at both local and regional scales by fostering synergies, for example "for flood protection and biodiversity protection" [11]. Similar concepts are expressed by Carter et al. [49] quoted by Busayo et al. [10] (p. 5). SP has proven to be key in promoting ACC and resilience mainly in cities [10]. Bruneniece and Klavins [50] emphasize the critical importance of regional and local governmental agencies in terms of adaptation. Indeed, these institutions usually hold accurate information regarding both local contexts and conditions that can foster or hinder environmental change. Lazoglou and Serraos also emphasized that the Regional SP frameworks "of Western Macedonia [are] central to promote the adaptation to the expected impacts of climate change" [51]. Hurlimann and March [52] remark on the role of SP, in the context of adaptation and report on six reasons why SP can deal with adaptation. Wilson [53] focuses on adaptation to climate change and the task of SP and development plans in the UK. The author emphasizes the pivotal function of local SP as a means for promoting adaptation. Thus, the role of SP is crucial for ACC [4,50,52,53].

Ledda et al. [4] stress that the regional plans represent a framework for introducing adaptation concepts at a sub-regional scale, "i.e., for addressing municipal master plans to making local landscapes and territories more resilient to climate changes" [4]. Ledda et al. [4] stressed a certain lack of studies addressing ACC in regional SP tools adopted in Sardinia. Thus, they proposed and applied a set of criteria to assess the performance of the regional plans and programs in terms of ACC.

3.2. Green Infrastructure and Spatial Planning

The European Commission considers GI as strategic solutions for safeguarding biodiversity and ecosystem services and important adaptation and mitigation measures to address climate change effects [17,54,55]. Nature-based solutions, GIs, and ecosystem-based adaptation are strategic in the challenge to climate change and communities' resilience [56]. In this regard, GIs provide benefits, in terms of hydrological flow regulation, reduction in soil erosion phenomena, pollutant filtration, restoration of degraded biodiversity [57]. GIs can contribute at safeguarding ecosystems and communities that are vulnerable to extreme climate events and natural disaster such as flooding, storms, forest fires, and avalanches [17]. The negative effects of these events "can often be reduced using GIs solutions such as functional flood plains, riparian woodland, protection forests in mountainous areas, barrier beaches and coastal wetlands [. . .]" [17]. Green roofs, a special type of GIs, contribute to the reduction in stormwater runoff [58] and heat island effect [59,60].

Gill et al. [61] address green infrastructures (GIs) as a resource for adapting urbanized areas to climate change and remark on the need to emphasize the role of GI in terms of adaptation in planning and policy instruments at all levels. SP is key to promoting the use of GI as a solution to address climate change [62]. Irga et al. [63] analyzed the dissemination of policy instruments aimed at the design of GIs in Australia, which concerned green roofs and green walls. Irga et al. [63] claimed the importance of local spatial planning to favor GIs designs by developing strategies and adopting aimed policies. On the other hand, a better integration of GIs in spatial planning could be achieved through a multi-level approach: spatial multi-scale integration by improving connectivity; resources integration by detecting GIs components and related ecosystem services; social–economic integration, which can be achieved by updating current spatial planning methods [64]. The implementation of GI depends on: planning aspects, for example the availability of specific planning tools [63]; stakeholders' interest; institutional organization; participation and coordination [62]. A lack of financial resources hinders the planning of GIs at a local scale [65]. Matthews et al. [62] argued that the planning and successful implementation of GIs as climate adaptation measures depends on biophysical and social factors, i.e., areas available for greening, species characteristics and urban morphology, but also governance aspects and involvement of citizens in decisional processes. SP should involve the design of large-scale green infrastructure to enhance its function in adapting to climate change: e.g., a metropolitan area can be divided into more vulnerable climate zones and GIs could be planned for each zone and assessed by comparing different climate scenarios to make GIs planning more effective [66]. Ecosystem services mapping, with a focus on supply and demand at the municipal level, can promote actions concerning GIs implementation, including parks and urban ecosystems, and the updating of urban plans [62]. The integration of GIs in spatial planning could be eased through appropriate indicators [67–69]: institutions should expand the GIs database to determine more specific city-scale indicators that include social, ecological, and environmental factors suitable for GIs implementation and monitoring [68]. Some authors have addressed the role of GIs in flood protection and stormwater runoff mitigation by focusing on spatial planning and indicators to identify priority areas [70]. Italian institutional bodies dealt with adaptation to climate change by integrating GIs' regional or local policies. As an example, some Italian cities adopted the so-called Green City Guidelines [71], which include GIs as a measure for promoting adaptation to climate change. In 2020, the Metropolitan City of Genoa for GIs planning explicitly focused on adaptation to climate change [72]. In 2020, the Region of Umbria considered GIs in a guidance for drafting the Spatial Strategic Program mainly for reducing climate change effects [73]. Thus, in Italy, a certain interest in GI is growing for promoting adaptation to climate change in spatial planning processes.

4. Materials and Method

In this section, we describe the methodological approach. Firstly, we provide the reader with the list of regional plans considered in this study. Secondly, we introduce the

criteria adopted to scrutinize the plans in terms of inclusion of adaptation to climate change and GI concepts.

4.1. Planning Tools Selection

We scrutinized the regional planning tools (including the strategic environmental assessment—SEA—report when available) described in Table 2.

Table 2. The pool of documents scrutinized in this study.

	Code	Name	References	Year of Approval	Main Mission	SEA Report
Sardinia (Italy)	RHP	Regional Hydrogeological Plan	Autonomous Region of Sardinia [74]	2006	Land defense and hydrogeological risk prevention	No
	RLP	Regional Landscape Plan	Autonomous Region of Sardinia [75]	2006	Protection and valorization of local landscapes	No
Wielkopolska (Poland)	EPP	Environmental Protection Programme	The Wielkopolska Regional Parliament [76]	2020	Undertaking activities in the field of landscape protection and shaping in the process of planning development	Yes
	SDP	Spatial Development Plan	The Wielkopolska Regional Parliament [77]	2019	Conducting spatial policy within the administrative boundaries of the region	Yes

As for Sardinia, the Regional Hydrogeological Plan (RHP) has been adopted in 2006 by the Autonomous Region of Sardinia. The plan provides guidelines, sectoral actions, technical standards, and general prescriptions for the prevention of hydrogeological hazards and risks in the regional river basin and hydrogeological hazard areas. RHP regulates areas of very high, high, medium, and moderate hydraulic and landslide hazard. The Regional Landscape Plan (RLP) aims to protect the landscape, with the dual purpose of preserving its quality elements and promoting its improvement through restoration and restructuring, even deep restoration when it appears degraded and compromised. RLP relies on three pillars, meaning 'environmental', 'historical and cultural' and 'settlement' settings, and it affects the regional territory, particularly twenty-seven coastal landscape units (LU). An LU consists of regional areas with similar environmental, historical and cultural, and settlement characteristics. The municipal master plans adopted in Sardinia must be consistent with RHP and RLP.

As for Wielkopolska, the Spatial Development Plan (SDP) has been adopted in 2019 by the Wielkopolska Regional Parliament. This is the most important strategic document for the Wielkopolska Region, which defines the spatial policy within the administrative border of the region. The plan defines the model of spatial development, the objectives of spatial policy and directions of spatial development of the region as well as the distribution of public purpose investments of supra-local importance. This document also contains a detailed analysis of development directions for the functional area of the voivodeship capital. The Environmental Protection Program (EPP) for the Wielkopolska Region until 2030 has been adopted in 2020 by the Wielkopolska Regional Parliament and implements an ecological policy for the region with the assumptions of the most important national and EU strategic documents. Conclusions and recommendations formulated in both documents should be reflected in planning documents at the regional and local level.

4.2. Adaptation to Climate Change: Assessment Criteria

We applied the criteria proposed by Ledda et al. [4]. Ledda et al. [4] focused on the regional plans adopted by the Autonomous Region of Sardinia (Italy), south European Mediterranean region, which is an area that will be negatively affected by climate change in the coming decades. Ledda et al. [4] aimed at proposing and applied a method rooted in the scientific literature and adaptation strategies with the purpose of scrutinizing a set of regional plans related to spatial planning issues. The authors performed a document analysis according to the following steps: (i) collection of the main strategic regional plans; (ii) scrutiny of the plans by using specific criteria (Table 3), to assess if, and to what extent, adaptation to climate change concepts were considered by the plans.

Table 3. Criteria applied to scrutinize the plans (after Ledda et al., 2020; [4]).

Criteria	Description	References
Reference to adaptation strategies	The plans refer to climate change adaptation strategies.	[2,78]
Inclusion of explicit or implicit adaptation measures	The plans include (i) explicit adaptation measures (i.e., measures specifically set as a response to climate change), or (ii) implicit measures (i.e., measures that have not been set as a response to climate change but can be effective in terms of adaptation to climate change).	[2,6,79–81]
Identification of responsible bodies for implementing Explicit adaptation measures	The plans clearly identified the responsible bodies for implementing Explicit adaptation measures.	[2,82]

The criteria were used to scrutinize if the plans: referred to adaptation strategies (regional, national, European, or international climate change adaptation strategies); included explicit (measures specifically defined in response to climate change) or implicit (that have not been defined as a response to climate change but are useful for adaptation) measures; identified the responsible bodies for implementing explicit adaptation measures.

4.3. Green Infrastructure and Spatial Planning: Assessment Criteria

De Montis et al. [18] focused on the integration of Green Infrastructure (GI) concepts in regional plans and programs and proposed and applied a complex index to do so. The study aimed at clarifying if—and to what extent—GI concepts were included in regional plans and programs adopted in Sardinia (Italy). De Montis et al. [18] defined and applied a quali–quantitative multicriteria method for selecting and scrutinizing regional plans and programs. This method was based on content analysis, inspired by similar criteria-based frameworks, and designed to enable a comparative assessment of Sardinian planning tools with respect to other countries and regions. The method included the use of a composite indicator—i.e., the Complex Index of Green Infrastructure Integration (CIGI)—for ascertaining the intensity of the consideration of GI themes and criticalities in plans and programs. While the methodologic details on the design of CIGI can be retrieved in De Montis et al. [18], here, we focus on the main elements: simple criteria (Table 4), scoring rule (Table 5), and criteria aggregation pattern (Equations (1)–(3)).

Table 4. Complex Index of Gi Integration: simple criteria (source: De Montis et al., 2022; [18]).

Domain	Code	Criteria
Explicit	EC1	Definition of GI
	EC2	Provisions concerning the design, valorization, management, maintenance of GI
	EC3	Indicators
Implicit	IC1	Strategies based on ecological networks, natural and semi-natural areas conservation
	IC2	Provision of actions for soil conservation and ecosystem/habitat/landscape protection
	IC3	Indicators

Table 5. Scoring system applied to assess the integration of Green Infrastructure (GI) concepts in the plans (after De Montis et al., 2022; [18]).

Score		Motivation
Quantitative	Qualitative	
1	No integration	GI concepts are not mentioned.
2	Barely acceptable	GI concepts are considered in a barely acceptable manner.
3	Acceptable	GI concepts are considered in an acceptable way.
4	Good	GI concepts are mentioned in a good way.
5	Excellent	GI concepts are satisfactorily considered.

The full expression of the composite indicator CIGI reads as follows (De Montis et al., [18]):

$$\mathrm{CIGI} = w_1 * \mathrm{CIGEI} + w_2 * \mathrm{CIGII} \quad (1)$$

where w_1 and w_2 (with $w_1 + w_2 = 1$) are the weights of the domain indicators Complex Index of GI Explicit Integration (CIGEI) and Complex Index of GI Implicit Integration (CIGII), which are calculated according to the following equations:

$$\mathrm{CIGEI} = \sum_{1}^{3} w_{Ei} * EC_{Ei} \quad (2)$$

$$\mathrm{CIGII} = \sum_{1}^{3} w_{Ii} * IC_{Ii} \quad (3)$$

where w_{Ei} and w_{Ii} are the weights of—respectively—the simple explicit (EC_{Ei}) and implicit (IC_{Ii}) criteria, with $\sum_1^3 w_{Ei} = 1$ and $\sum_1^3 w_{Ii} = 1$. Weight of CIGEI = 2/3; weight of CIGII = 1/3.

5. Results and Discussion

In this section, we describe and discuss the main findings.

5.1. Adaptation to Climate Change

Table 6 summarizes the scrutiny of the regional plans. The second column lists the plans, while from the third to the sixth column, a check mark (✓) indicates if the criterion is met.

Table 6. Scrutiny of the regional plans: findings (after Ledda et al. [4]).

	Plans	Criteria			
		Reference to ACC Strategy	Indication of Adaptation Measures		Indication of Responsible Bodies for Implementation of Explicit Measures
			Explicit	Implicit	
Sardinia	RLP			✓	
	HSP			✓	
Wielkopolska	EPP	✓	✓		✓
	SDP			✓	

On the one hand, the Sardinian regional plans are devoid of reference to adaptation to climate change strategies and explicit adaptation measures (and thus the responsible bodies for their implementation). On the other hand, RLP and HSP include measures that can be effective in terms of adaptation to climate change (implicit adaptation measures). The implicit measures include "gray and green [measures], such as environmental regeneration, drainage systems, safeguarding of watercourses, and preserving ecological connectivity" [4]. As an example, the RLP refers to: depollution and environmental regeneration; preservation of ecological connections between coastal and inland areas through river corridors; maintaining the functionality of watercourses flowing toward the coast by ensuring the natural flow of surface water; etc. Meanwhile, the HSP refers to: riverbank protection; adjustment or construction of river embankments; slope protection from runoff phenomena; protective barriers against rock falls and landslides; reconstitution of vegetation cover; etc.

In case of the Wielkopolska Region, only the Environmental Protection Program [76] implements rules from higher-level adaptation strategies and plans (national and EU). In addition, this strategic document includes explicit adaptation measures and identifies some responsible agencies for the implementation of explicit adaptation measures. For this reason, the Environmental Protection Program, due to the lack of regional strategy for adaptation to climate change, should play a role of guidance for mainstreaming adaptation in the current spatial planning practices. Recommended directions of adaptation activities for the Wielkopolska Region include: flood protection of areas located in floodplains; recognition of the possibility of growing thermophilic plants and preparation of programs to secure good quality water. The Spatial Development Plan [77] includes only some measures that can be effective in terms of adaptation to climate change, but much more should be undertaken in this aspect. For example, the Spatial Development Plan (2019) includes some general recommendations such as: maintenance and introduction of mid-field; roadside and waterside plantings to improve ecological and climatic function; reducing low pollutant emissions; introducing environmentally friendly sources of local and regional transport; or designation of green areas supporting the process of self-cleaning atmosphere, especially in urban areas. However, the main provisions of the Spatial Development Plan (2030) are consistent with the adopted concept of the Environmental Protection Program (2020).

Three out of four regional plans lack clear references to climate change and adaptation concepts. However, the plans set implicit adaptation measures that can increase the resilience of the regional contexts against the negative consequence due to climate change [4]. Implicit measures—such as roadside and waterside plantings improving ecological and climatic function (SDP, Wielkopolska Region) and drainage systems dealing with the excess of water and the design of green areas (RLP and HSP, Sardinia)—can have a key role as entry points for explicit adaptation measures [4,78]. However, the plans need to be updated to clearly introduce adaptation principles and guidance acknowledged at international [83] and European [1] levels. Furthermore, the two plans adopted in Sardinia will have to be consistent with the regional strategy for adaptation to climate change approved in 2019 [8] as they are the framework for sub-regional planning tools.

The EPP (Wielkopolska) met three criteria, which are the most relevant to adaptation. The plan clearly provides a reference to adaptation strategies, adaptation measures, and an indication of responsible bodies for implementation of the explicit measures. The reference to adaptation strategies can be considered as the first step to introduce adaptation principia from a higher (European or national) to sub-regional (provincial or municipal) scale [4]. According to England et al. [44], the consistency among policies is important in terms of increased efficiency and effectiveness and reduced competition for scarce budgets and resources. The definition of explicit adaptation measures should be considered the minimum to meet adaptation objectives consistent with adaptation strategies. However, adaptation measures have to be tailored to specific geographical and climate contexts to be effective [4,81]. Finally, the plan identifies the agencies for the implementation of explicit adaptation measures, and this is a key issue in terms of effective adaptation [84] partly because "[. . .] each node of the administrative network should be known, and alerted when needed, across horizontal and vertical levels. In such a network, the nodes are the actors, who are responsible for certain adaptation measures, while the links stand for the relationships and interactions between the actors" [4].

In the case of Sardinia, we analyzed documents approved 15 years ago. Therefore, the plans need to be updated to include the principles and objectives of the regional strategy for adaptation [8]. By contrast, the Wielkopolska region shows very recent (i.e., approved in 2019 and 2020) tools, even though they are still not sufficiently adapted to climate change issues. This is due to the lack of regional strategy for adaptation, which should be a starting point in this context. The Marshal Office of the Wielkopolska Region should prepare the Regional Strategy for Adaptation to Climate Change as soon as possible.

5.2. Green Infrastructures

Table 7 summarizes the outcomes. The criteria (columns 4–9) quantify the qualitative assessment on the performance of each plan.

Table 7. CIGI: scores assigned to the simple criteria and resulting values for domain and composite indicators plans (after De Montis et al., 2022; [18]). 'A' stands for the arithmetic mean of the scores assigned to RHP and RLP; as an example, for Sardinia, the arithmetic mean A of EC1 = (1 + 1)/2 = 1. 'B' stands for the arithmetic mean of the scores assigned to EPP and SDP; as an example, for Wielkopolska, the arithmetic mean B of IC2 = (3 + 4)/2 = 3.50. 'C' stands for the arithmetic mean of 'A' and 'B', i.e., (A + B)/2.

Regions (Code)	Plans	Calculation	EC1	EC2	EC3	IC1	IC2	IC3	CIGEI	CIGII	CIGI
Sardinia (A)	RHP		1	2	1	1	4	1	1.33	2.00	1.56
	RLP		1	1	1	2	3	1	1.00	2.00	1.33
		Mean A	1.00	1.50	1.00	1.50	3.50	1.00	1.17	2.00	1.45
Wielkopolska (B)	EPP		1	1	1	3	3	2	1.00	2.66	1.55
	SDP		1	1	1	4	4	1	1.00	3.00	1.67
		Mean B	1.00	1.00	1.00	3.50	3.50	1.50	1.00	2.83	1.61
		Mean C	1.00	1.25	1.00	2.50	3.50	1.25	1.08	2.42	1.53
Sardinia		(A-C)/C	0%	20%	0%	−40%	0%	−20%	8%	−17%	−5%
Wielkopolska		(B-C)/C	0%	−20%	0%	40%	0%	20%	−8%	17%	5%

RHP and RLP do not report any definition of GIs (EC1). The RHP suggests the use of GIs as a countermeasure to hydrogeological instability, such as landslides and floods (EC2 and IC2). The RHP refers to "green roofs, permeable flooring, grassy canals, plant strips, and buffer strips" [18] and includes both structural and not-structural naturalistic engineering measures. Indicators are not mentioned in the plan (EC3 and IC3). The RLP refers to GIs (IC2) in implicit terms such as "[. . .] urban green spaces, conservative farming for soil conservation, cover crops" [18]. The RLP aims at establishing, enhancing, restoring,

and conserving natural areas through landscape and habitat connectivity (IC1). The plan does not mention any indicators (EC3).

In the case of the Wielkopolska Region, there is no national document or strategy in Poland which will implement GIs from the national to regional level. Furthermore, in the absence of a coherent spatial planning system, Poland is increasingly losing its natural potential to create GIs due to a growing fragmentation of ecosystems. Currently, one of the major barriers is the lack of effective legal instruments, regulations and guidelines. So, the level of GIs integration is barely acceptable because none of the scrutinized documents explicitly include definitions, provisions and indicators concerning GIs. They have implemented only some general recommendation: preventing ecosystem fragmentation; maintaining ecological connectivity; and re-naturalizing degraded and anthropogenically transformed areas.

According to the CIGI, the plans of the Wielkopolska Region show a better performance than the plans adopted in Sardinia. However, the regions show similar very low quality in terms of GIs concepts integration, excluding IC1 compared to which Wielkopolska has a significantly higher average score (+40%) than Sardinia. The Sardinian plans did not refer to the concept of GI: this because the plans are very old (2006) and cannot refer to strategies such as the EU Strategy to GIs [17].

Both Sardinia and Wielkopolska show a certain lack of consideration of GIs. The findings confirm the results of previous studies [18,85,86]. The plans did not explicitly refer to the definition of GI (EC1), provisions concerning the design, valorization, management, maintenance of GI (EC2), and indicators (EC3). In this regard, our results are similar to the output obtained by Di Marino et al. [85], who investigated the regional planning policy of the Uusimaa Region (Finland) and found that "the concept of GI has not been introduced yet" [18]. Grădinaru and Hersperger [86] also found comparable findings in a study concerning spatial plans adopted by European urban regions. As for EC2, the Sardinian RHP addressed GI implementation, management, and conservation, also implicitly (IC2) as EPP and SDP (Wielkopolska). GIs are implicitly integrated in the plans, and this could pave the way for an explicit consideration of GIs. However, this conjecture needs to be investigated with further research. The plans did not include any explicit reference to GI indicators (EC3), while EPP refers implicitly to them. According to De Montis et al. [18], "[the] inclusion of ecological indicators specifically defined for measuring the effectiveness of GIs would be desirable", as such indicators can be used to "measure climate and microclimatic modifications [...]" (De Montis et al., [18]; see also Pakzad et al., [87]). In addition, GI indicators are also useful in strategic environmental assessment procedures: for example, in the monitoring phase of plans and programs that may affect the environment [18].

6. Conclusions

Spatial planning has a key role in the promotion of adaptation to climate change (ACC) and green infrastructure (GI) concepts and principles as well as adequate planned measures. In this paper, we answered to two research questions (RQs). RQ1 aimed at investigating if—and to what extent—key concepts of ACC and GI characterized the regional planning process of Sardinia (Italy) and Wielkopolska (Poland) and pointing out the main strengths and weaknesses of the tools. RQ2 had the purpose of stressing if and how the current organization of the spatial planning system of both Italy and Poland has potential to ease the integration of ACC and ecosystem services—delivered by GI—into practice.

As for RQ1, we found out that the major regional spatial planning tools of both regions are deficient in terms of consideration of ACC and GI issues. The plans mainly met implicit performance criteria. Thus, future updates of the plans must integrate ACC and GI concepts according to European, national, and regional strategies (ACC) or provincial guidance (GIs).

As for RQ2, the multi-level and multi-actor planning system of Italy and Poland can contribute at the integration of adaptation to climate change and GI concepts at the

regional and sub-regional scale. Italy has adopted a national adaptation strategy in 2015 [6]. Thus, Sardinia benefits from a national (and from 2019, regional) framework that promotes adaptation to climate change, i.e., the national [6] and regional adaptation strategy [8]. In this regard, the planning system of both states has a central role for the promotion of adaptation from a higher (state) level to lower (sub-regional) level. Neither Italy nor Poland have adopted a national GI yet, but some Italian public administrations adopted guidelines for the design and implementation of GI at the provincial level.

We might speculate that the regional plans show a weak attitude to integrating ACC and GI concepts because of the slowness of the regions to fully integrate such concepts into the regional legislative framework (see Wielkopolska) and to update the plans (see Sardinia). On the one hand, a satisfactory integration of the EU strategies on ACC and GI into regional regulations and guidance documents of Wielkopolska might be relevant to the mainstreaming of ACC, resilience and GI in plans related to SP issues. SP could promote the consideration of such concepts into planning processes, e.g., in the context of strategic environmental assessment. On the other hand, Sardinia needs to update the regional plans, according to the regional strategy for ACC and better include GI concepts into the SP processes. In Poland, there is a clear need to develop or update planning documents and adaptation strategies for regions and subregions, which undergo energy transformation processes relating to moving away from coal. These are strongly transformed areas, in which the processes of mitigation and ACC play a special role. In the case of the Wielkopolska region, this applies to the Konińskie Basin of Brown Coal.

We feel that this research can contribute to the scientific panorama as: (i) it provides the scholars with a methodological approach replicable in similar European geographical contexts; (ii) the study might be of inspiration for planners to assess the quality of regional plans and stress their strengths and weaknesses; (iii) the performance criteria proposed in this study have potential to be utilized as a checklist, i.e., a sort of list of criteria that need to be met in the context of planning processes; (iv) it emphasizes the role of adaptation to climate change and GI concepts in regional spatial planning and provides the regional administrations with reasons that support the need to increase the climate resilience of territories and population to preserve human (and non-human) life. European regions can be inspired by this study to promote the use of GIs for increasing territorial resilience.

The main limitations of this research regard: (i) the small set of regional plans scrutinized and (ii) the basic performance criteria adopted. We aim at increasing the sample of plans and considering additional performance criteria in future research. A further limitation concerns the need to investigate how regional plans are implemented in practice. Future research should investigate what barriers—regulatory or otherwise—hinder the implementation of the scrutinized plans in regard to ACC and promoting the use of GI.

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