

Integrating adaptation to climate change in regional plans and programmes: the role of Strategic Environmental Assessment

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Abstract

Climate changes exert negative impacts on the global environments and the human beings. They imply more frequent extreme weather events, which are responsible of sea level rise, coastal erosion, flooding, droughts, and desertification. Mitigation and adaptation represent intertwined strategies for counteracting climate changes. Mitigation is associated to the lessening of the causes of climate changes and includes actions reducing greenhouse gas emissions. Adaptation is a proactive concept addressing how humans can adapt and benefit from climate change. The mainstreaming and integration of adaptation to climate change into routine practice can be favored by Strategic Environmental Assessment (SEA) of regional policies, plans and programmes. In this study, we aim at scrutinizing a set of SEA reports of regional plans and programmes adopted in Sardinia (Italy), to investigate if -and to what extent- adaptation to climate change has characterized planning and programming tools. Evidence shows that the integration of adaptation-driven issues into regional planning is still in its infancy but presents the signs of promising expansion.

Keywords: Strategic Environmental Assessment, adaptation to climate change, regional plans and programmes, content analysis, regional strategy for adaptation to climate change.

1. Introduction

Extreme and more frequent weather events -as well as drought and floods- are affecting human life (IPCC, 2014). As a response to a changing climate, many international climate governance tools have been released, including the United Nations Framework Convention on Climate Change (United Nations, 1992) and the Paris Agreement (United Nations, 2015). The Paris Agreement remarks the need of climate change mitigation and adaptation approaches. The ‘Mitigation’ approach aims at reducing the emission of greenhouse gases into the Earth’s atmosphere, while ‘adaptation’ aims at adjusting our life to actual or expected future climate. Mitigation is crucial for reducing the effects of climate change, but it is insufficient and must be supplemented by effective short-term actions, such as the adaptation measures (Smit et al., 2001; OECD, 2010; Stiller and Meijerink, 2016).

Adaptation to Climate Change (ACC) is a central topic worldwide (IPCC, 2014) and in Europe (European Commission, 2013a). The European Union strategy (EU strategy) on ACC aims at making the European member states more resilient to a changing climate and requires the adoption of national adaptation strategies (European Commission, 2013a). According to the European Environment Agency (EEA), most European states adopted both national adaptation strategies and plans (EEA, 2019). The EU strategy principia have been transposed in Italy through the National Climate Change Adaptation Strategy (NCCAS) (MEPLS, 2015) and the National Climate Change Adaptation Plan (NCCAP) (MEPLS, 2017) (Ledda et al., 2020). In Italy, a strategy mainly concerns principia and targets supported by politicians and defines a framework for subordinate operative tools, such as plans and programmes. This implies that plans and programs elucidate specific objectives and measures (or actions) required to realize the principia and achieve the targets delineated in the strategies.

In 2019, the Autonomous Region of Sardinia (ARS, Italy) adopted the regional strategy for

ACC (RSACC), which is consistent with EU strategy, NCCAS, and NCCAP. RSACC (Autonomous Region of Sardinia, 2019a) defines a coherence reference framework for the design of regional plans. The RSACC includes adaptation objectives that must be introduced in plans and programmes at local and regional scale. In this regard, the regional level is key for defining in plans and programmes (P/P) adaptation objectives and measures (European Commission, 2013a; Lukat et al., 2016; Ledda et al., 2020), that should be translated in operational adaptation actions at local level.

According to the Organization for Economic Co-operation and Development (OECD, 2010) and European Commission (2013b), Strategic Environmental Assessment (SEA) is a major opportunity for integrating climate change adaptation issues into P/P. SEA was officially introduced in the European Union by the Directive 2001/42/EC (SEA Directive; European Parliament and Council, 2001) with the aim at considering and assessing the effects of certain P/P on the environment. According to the European Commission (2013c), SEA procedures should consider climatic factors as relevant drivers in processes impacting the environment.

The core document of SEA is the environmental report (SEA report), which is an integral part of P/P proposal and key to mainstreaming ACC into sectoral instruments. Scientific literature has not sufficiently investigated the role of the SEA report as a tool to integrating climate change adaptation considerations in regional P/P.

This study revolves around this research question: can we provide planners and decision makers with a method able to support the mainstreaming of ACC considerations in planning and programming tools through the SEA process? Thus, we focus on the construction of a method to define the main concepts to be included in SEA reports to promote ACC in plans and programmes. We are interested in tailoring the method on basic issues that a SEA report must address for improving territorial resilience to a changing climate. The method proposed in this study has been used in practice as part of the process for drafting up SEA guidelines aimed at mainstreaming ACC

in regional plans and programmes released in Sardinia (Italy). Indeed, one of the main goals of this study was to provide the Autonomous Region of Sardinia with a set of operative guidance useful for addressing the SEA procedures of plans and programmes of a regional and local scale, towards adaptation to climate change issues. Such key considerations were summarized in specific guidelines approved as an annex of the RSACC report titled ‘Guidelines for integrating adaptation to climate change into the strategic environmental assessment procedure’ (Autonomous Region of Sardinia, 2019b). The guidelines address which issues connected to ACC should be integrated in each phase of the SEA procedure.

The paper unfolds as follows. In the next Section 2, we provide an overview on adaptation to climate change and Strategic Environmental Assessment. In Section 3, we describe the method, by introducing the criteria used for scrutinizing the SEA reports. In Section 4, we introduce the case study and illustrate the results. In Section 5, we discuss the findings and, in Section 6, we report the concluding remarks.

2. Adaptation to climate change and Strategic Environmental Assessment: an overview

SEA aims at assessing the effects of certain plans and programmes on the environment. SEA should be integrated in the design of planning and programming tools since the early stages (European Commission, 2005). The main document of the procedure -i.e. the SEA report- (i) identifies, describes, and assesses the effects of P/P (including direct, indirect, synergistic, cumulative, long and short term effects), (ii) reports on studies and analysis considered in the SEA process, and (iii) provides information concerning the public participation.

Climate is already part of the factors expected to be properly addressed in the SEA procedures (European Commission, 2013c). This opportunity is confirmed by other authoritative voices. As per the study of Byer et al. (2018), climate change is a hot topic in impact assessment at project and strategic level. According to the Organisation for Economic Co-operation and Development (OECD, 2010), “[the] integration of climate change into strategic planning through the application

of SEA should lead to better informed, evidence-based PPPs [policies, plans, and programmes] that are more sustainable in the context of a changing climate, and more capable of delivering progress on human development”. In 2013, the European Commission complained that “SEA has been designed to assess impacts on the environment, rather than *viceversa* – e.g. to assess impacts of a changing climate on a programme. As a matter of fact, climate change impacts are closely related to the environment and, typically, biodiversity and ecosystems” (European Commission, 2013b).

Research interest concerning climate change and SEA is not new (Larsen and Kørnø, 2009; Fischer et al., 2011; Larsen et al., 2012, 2013; Wende et al., 2012; do Nascimento Nadruz et al., 2018). Fundingsland Tetlow and Hanusch (2012) report on mitigation and adaptation to climate change, by stressing that the emission of greenhouse gases was scarcely addressed in SEA practice, while the inclusion of ACC in SEA required a change of perspective. They argue that “SEA must face global challenges and develop tools to better incorporate environmental limits and climate change”. Wende et al. (2012) proposed an assessment framework including criteria for gauging the role of SEA as a tool for steering the regional plans toward the reduction of CO₂ in Saxony (Germany) and East of England (England, the UK). Such a framework was developed according to international and national guidance concerning the interplay between climate change and SEA.

Wende et al. (2012) remarked weaknesses concerning the lack of targets aimed at CO₂ reduction in the Sustainability Appraisals (East of England) and scarce consideration of climate change in SEAs (Saxony) of the regional plans scrutinized. Larsen and Kørnø (2009) focused on the mainstreaming of climate change in SEA applied on river basin management plans, in Denmark, and pointed out that climate change should be considered in terms of mitigation, adaptation, and baseline adaptation. Posas (2011) used a set of criteria to scrutinize “36 English local development framework core strategy sustainability appraisals” (Posas, 2011) and focused on the consideration of climate change in SEA. These criteria were referred to the measures proposed by the UK Environment Agency’s guidance (Posas, 2011; Environment Agency, 2007). Posas (2011)

identified Sustainability Appraisals that partially or fully met the selected criteria. Fischer et al. (2011) assessed the quality of SEA reports and the level of consideration of climate change mitigation of municipal waste management strategies. The authors proposed and applied a version of the so-called 'quality review package', which consists of criteria rooted in the contents of the SEA Directive. Similar versions of the quality review package have also been applied in other contexts (Fischer, 2010; De Montis, 2014). As for the concluding remarks, *inter alia*, Fischer et al. (2011) found that the ten best performing SEAs considered objectives concerning the reduction of carbon emissions, but specific targets were not included for the municipal waste management strategies. Larsen et al. (2012) dealt with adaptation and mitigation to climate change in Denmark and, among other things, scrutinized 149 SEA reports to assess the integration of climate change issues in SEAs of municipal spatial, local spatial, and sector plans. The authors pointed out the poor assessment of synergies between adaptation and mitigation in the scrutinized SEA reports. Larsen et al. (2013) focused on climate change uncertainties in SEA, in Denmark. The authors analyzed 151 SEA reports with the purpose of checking if (i) the climate change was considered, (ii) the uncertainty acknowledged, and (iii) ad hoc strategies adopted in such documents. Larsen et al. (2013) found out that most SEAs have ignored -or minimized the consideration of- climate change uncertainties, and barely 22 SEA reports referred to adaptation. According to the findings and considering the research point of view, Larsen et al. (2013, p. 149) remarked "that significant gaps remain in knowledge as to why uncertainty is inadequately addressed and communicated in Strategic Environmental Assessments". do Nascimento Nadruz et al. (2018) focused on the inclusion of climate change issues in SEA practice in Brasil. The authors scrutinized 35 SEA reports -concerning energy, regional development, transport, and tourism plans- by using the set of criteria proposed by Wende et al. (2012) and identified a general poor consideration of climate change in the documents, which primarily focused on mitigation rather than adaptation. do Nascimento Nadruz et al. (2018, p. 52) concluded that the "integration of CC [climate change]

issues into the SEA-supported sectoral planning/regional development in Brazil can be considered limited and disappointing”.

While many scholars have investigated the interplay between SEA and climate change worldwide, the literature on the Italian context related to this theme is still lacking. Pietrapertosa et al (2021) recently proposed an analysis of Italian regional, provincial and municipal planning framework related to climate change mitigation and adaptation, which highlights that only two regions (i.e. Sardinia and Lombardy) adopted an Adaptation Strategy and one region (i.e. Emilia Romagna) adopted one integrated Mitigation and Adaptation Strategy so far. A study concerning Sardinian regional P/P (Ledda et al., 2020) shows that the more recently approved plans contain measures which - implicitly or explicitly - can contribute to increasing the regional resilience.

SEA has been acknowledged as “the vehicle for the implementation of climate protection within spatial planning (Forsyth et al., 2009), [...]” (Wende et al., 2012) and is key in terms of transparent decision-making processes (Fundingsland Tetlow and Hanusch, 2012). The importance of SEA in the context of climate change is confirmed by international documents such as the ‘Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment’ (European Commission, 2013c).

3. A method for assessing the attitude toward adaptation to climate change

We propose a qualitative approach based on contents analysis. Content analysis is well-know and applied by several scholars, also to scrutinize SEA reports (Fischer, 2012; De Montis et al., 2016). Firstly, we retrieved publications, by filtering major databases (Scopus, Web of Science, and Google) through all possible combinations of the following keywords: SEA report, adaptation, climate change, adaptation to climate change, criteria, and strategic environmental assessment. We retrieved 43 documents including articles and other publications (i.e. gray literature). A finer reading has led to the selection of seven essays concerning: ACC and mainstreaming of ACC or criteria useful for scrutinizing SEA reports, or contents analysis. Starting from the analysis of

publications focusing on the interplay between SEA and ACC, we have built a set of five basic criteria. We focus on very simple and first-stage criteria because in Italy the integration between ACC concepts in planning and programming tools is still in its infancy. At the time of the research (2018), Sardinia was one the few Italian regions interested in mainstreaming ACC into the regional apparatus, in terms of governance, plans and programmes, and SEA. Thus, we could not expect the full integration of ACC concepts into planning and programming tools. Furthermore, we decided to select five broad criteria, so that they could be used to carry out the analysis on sectoral plans relating to very different themes. Moreover, general criteria allow the methodology to be applied to P/P at different scales and in different territorial contexts. The five criteria selected are not the best in absolute terms, but they are drawn from scientific essays and European institutional documents and fit well to the Italian and European contexts.

Scholars have designed criteria-based methods for scrutinizing SEA reports in different contexts, including climate change (see, inter alia, Fischer et al. 2010, 2011; Posas, 2011; Wende et al., 2012; Larsen et al., 2012; De Montis, 2014; do Nascimento Nadruz et al., 2018). Likewise, we propose a SEA report evaluation method based on five criteria (Table 1).

Code	Focus	Main question	References
CR1	Strategies of adaptation to climate changes	Does the SEA report refer to national, European, or international climate change adaptation strategies?	European Commission (2013a), Ledda (2020), MEPLS (2015).
CR2	Climate change analysis	... include climate analysis on past weather events and climate trends and projections?	Prutsch et al. (2010), Smith et al. (2005), Kosanic et al. (2019), Dorward et al. (2020), Girvetz et al. (2009).
CR3	CR3e Explicit adaptation objectives	... contain explicit adaptation objectives specifically defined in response to climate change, or implicit objectives, which have not been defined as a response to climate change, but are useful in terms of ACC?	Runhaar et al. (2018); Byer et al. (2018).
	CR3i Implicit adaptation objectives		
CR4	Monitoring indicators	... define indicators useful for monitoring the effects of climate change and ACC	European Parliament and Council (2001), Gachechiladze-Bozhesku and

Code	Focus	Main question	References
		measures?	Fischer (2012).

Table 1 Criteria used to scrutinize the plans.

The criteria are rooted in European and Italian national ACC strategies and international scientific literature. Criterion 1 (CR1) evaluates SEA reports by focusing on the capacity to refer to international or national strategies on ACC. CR2 focuses on the reporting of climate analysis of past events and future tendencies. CR3 evaluates the inclination of SEA reports to quote explicit (CR3e) and implicit (CR3i) regional ACC objectives. CR4 is designed to consider the reference to monitoring indicators able to gauge the effects of ACC measures.

We selected CR1 following the European (European Commission, 2013a) and Italian (MEPLS, 2015) adaptation strategies, which set a reference framework for the regional planning and programming systems and, in turn, for regional and sub-regional P/P. According to Ledda et al. (2020), it “is important to figure out if the regional plans are consistent with common adaptation principia and guidelines” as the plans set a framework for local tools in which ACC actions can be defined and put into practice (for example, by municipal administrations). The drafting of the SEA report is a remarkable element of the planning and programming process and according to the SEA Directive the climatic dimension should find room in a SEA process. Consistency between the contents of SEA reports and supraordinate adaptation strategies is meaningful for defining consistent and context-specific adaptation objectives and measures.

As for CR2, we have been inspired by the evidence reported as follows. Prutsch et al. (2010) identify ten “good practices” guiding principles for ACC in the European context, concerning knowledge and awareness, stakeholder’s involvement, and uncertainties. One of the guiding principles concerns the potential impacts due to climate change. In this perspective, Prutsch et al. (2010), after Ribeiro et al. (2009), proposed an approach including six steps. We focus on two of them concerning: the “analys[is of] the impacts of past weather events and recent climate trends on key systems” and the “assess[ment of] potential likely future climate [...] scenarios” (Prutsch et al.,

2010, p. 13-14). Smith et al. (2005) stress that climate change projections, climate risks, and uncertainty are elements that need to be assessed when ACC must be integrated into development activities. Climate change can negatively affect biodiversity, as it exacerbates the effects due to other phenomena, such as habitat fragmentation (Kosanic et al., 2019), even though it is difficult to understand how species will cope with future climate scenarios, due to the lack of data concerning historical weather records and trend detection (more details in Kosanic et al., 2019). In general, the climate analysis is often the main starting issue for a correct study of ACC (Dorward et al., 2020; Girvetz et al., 2009; Smith et al., 2005).

With respect to the selection of CR3, we consider the following concepts and essays. According to Runhaar et al. (2018), scholars suggest that policies and practices integrated with (i.e. mainstreaming) ACC objectives have a positive role in terms of sustainable change. ACC mainstreaming has been given different definitions or meanings (Runhaar et al., 2018; Widmer, 2018). In this study, we consider 'mainstreaming' as a basic concept, i.e., "integrating [...] climate change adaptation objectives into existing sectoral policies and practices" (Runhaar et al., 2018). We are aware of the deeper meaning of climate adaptation mainstreaming, but this study focuses on minimum requirements that should be met to integrate ACC considerations in SEA reports of sectoral P/P. Then, we ascertain if the SEA reports include adaptation objectives that refer to the national or European adaptation strategies, or if the SEA reports define adaptation objectives regardless of higher hierarchical level adaptation strategies or other documents. In addition, we stress the relevance of adaptation objectives in impact assessment (IA) procedures. As reported by Byer et al. (2018), "[where] the country has national or relevant sectoral climate change plans in which climate change adaptation objectives have been established, these should be clearly identified and used in the IA. When objectives are not available, the IA should clearly define the objectives that the proposal is seeking to meet. IAs, especially for policies, programmes, and plans, can also be used to help set the objectives and strategies for climate change adaptation". We consider both

explicit (CR3e) and implicit (CR3i) adaptation objectives. CR3e refers to clear adaptation objectives included in International, European, national, or regional strategies, policies, or plans. Conversely, CR3i considers objectives that have potential to contribute to promote ACC (for example, increasing wooded areas, planning green infrastructures, water protection and saving, etc.).

As for the selection of CR4, we consider the following literature contributions. Strategic planning includes certain level of uncertainties and unexpected issues that can occur in the implementation phases. In terms of SEA effectiveness, many scholars acknowledged the crucial role of SEA follow-up (Persson and Nilsson, 2007; Gachechiladze-Bozhesku and Fischer, 2012; Azcárate et al., 2013; De Montis, 2013; De Montis et al., 2014). SEA follow-up consists of a series of activities, which include monitoring, evaluation, management, and communication (Persson and Nilsson, 2007), and that are implemented in “post-decisional stages of SEA” (Gachechiladze-Bozhesku and Fischer, 2012), i.e., when strategic decisions have been achieved. ‘Monitoring’ is part of the activities included in the SEA follow-up. The SEA Directive explicitly requires the UE Member States to monitor the effects of P/P, which contributes among other things at the identification of unforeseen negative effects and allows planners to define proper countermeasures (European Parliament and Council, 2001). According to Gachechiladze-Bozhesku and Fischer (2012, p. 24), “SEA monitoring may rely on indicators proposed for reaching SEA follow-up objectives and those set out in SEA recommendations”.

4. Application and results

4.1. 4.1. The case study: context and selection of plans and programmes

In the European Union, the Mediterranean region will be one of the most susceptible and vulnerable to the impacts of climate change in the next years (MEPLS, 2015). The EU strategy encouraged the member states to adopt national adaptation strategies and define adaptation

measures. Italy adopted its adaptation strategy in 2015 (MEPLS, 2015). The Italian NSACC defined adaptation measures tailored for specific national macro-regions with similar climatic conditions (MEPLS, 2017). Each macro-region shows specific climatic scenarios that require ad hoc adaptation rationales: the region of Sardinia belongs to the so-called macro-region ‘Islands and south of Italy’.

The regional level plays a key role for defining and implementing adaptation measures (European Commission, 2013a; Lukat et al., 2016; Ledda et al., 2020). Sardinia (Figure 1) is one of the few Italian regions that has adopted an adaptation strategy, the Regional Adaptation to Climate Change Strategy (RACCS) in February 2019 (Autonomous Region of Sardinia, 2019a). The RACCS incorporates the principia of EU strategy, NSACC, and NCCAP, according to a top-down approach, but also integrates the stakeholders’ point of view, thereby reflecting a bottom-up approach (Ledda et al., 2020).



Figure 1 The red circle localizes the Italian island of Sardinia.

In this study, we scrutinize the P/Ps approved between 2007 and 2018 and the related SEA reports completed by 2018. We aimed at considering all SEA reports of regional tools issued in Sardinia by 2018. In Table 2, each P/P is described with reference to year of publication, scope, law, and institutional web page.

1

2

Plan or Programme/SEA report	Code	Year	Scope	Law	Website
Flood Risk Management Plan (Piano di Gestione Rischio Alluvioni, in Italian)	FRMP	2016	The plan is designed to address operational and governance tools for reducing the negative consequences of floods on human health, environment, and society. The plan regards all aspects of flood risk management, including non-structural measures aimed at preventing and protecting against the occurrence of flood events.	Directive 2007/60/EC and Italian Legislative Decree 49/2010	https://www.regione.sardegna.it/j/v/2420?s=1&v=9&c=94070&na=1&n=10&esp=1&tb=14006
Water Management Plan of the hydrographic district of Sardinia (Piano di gestione del distretto idrografico della Sardegna)	WMP	2009-2015	The plan is the operational tool for planning, implementing, and monitoring measures concerning restoration and improvement of surface and underground water bodies.	Water Framework Directive (Directive 2000/60/EC)	http://www.regione.sardegna.it/speciali/pianogestionedi strettoidrografico/
Regional Energetic Environmental Plan 2015-2030 (Piano Energetico Ambientale Regionale)	REEP	2015	The Regional Administration pursues energy, socio-economic and environmental objectives through the Regional Environmental Energy Plan (REEP).	Directive 2009/28/EC and 2010/31/EU, Italian Legislative Decree 28/2011	https://www.regione.sardegna.it/documenti/1_274_20160129120420.pdf
Rural Development Programme 2014-2020 (Programma di sviluppo rurale)	RDP	2014	The RDP is the main financial instrument for the agricultural, agro-industrial and forestry sectors, and for the rural development of Sardinia. The RDP consists of six general Priorities and related specific 'sectors of interest' (Focus Area).	Directive 2009/28/EC, Directive 2010/31/EU, Italian Legislative Decree 28/2011	http://www.regione.sardegna.it/speciali/programmasvilupporurale/psr-20072013/il-programma/monitoraggio-e-valutazione
Regional Environmental Forest Plan (Piano Forestale Ambientale Regionale)	REFP	2007	The Plan outlines the strategies for the enhancement, protection and increase of the regional forestry resources, with specific focus on sustainable forest management.	Regulation (EC) 2173/2005, Directives 92/43/EEC 'Habitat' and 79/409/EC 'Birds', Italian Law 812/1978, Italian Law 184/1977, and others regulatory references	https://www.regione.sardegna.it/j/v/25?s=71168&v=2&c=9&t=1
Regional waste management plan concerning municipal waste (Piano regionale di gestione dei rifiuti - Sezione rifiuti urbani)	RWMPmw	2016 (updated 2008)	The plan aims at reducing the quantity of waste, improving the quality of waste, increasing the recycling of raw materials, minimizing the number of waste-to-energy plants, etc.	Italian Legislative Decree 152/2006	https://www.regione.sardegna.it/j/v/2425?s=81769&v=2&c=156&t=1&tb=13769
Regional waste management plan concerning special waste (Piano regionale di gestione dei rifiuti - Sezione rifiuti speciali)	RWMPsw	2012	The plan is the result of an in-depth analysis of the current plant and logistics scenario of the regional treatment system. The plan aims at a new assessment of the plant requirements and a greater incentive for recycling.	Directive 75/442/EEC, 91/156/EEC, 78/319/EC, 96/61/EC, 2008/98/EC, Italian Legislative Decree 152/2006, and others regulatory references	http://www.sardegnaambiente.it/documenti/18_330_20130122105942.pdf

Plan or Programme/SEA report	Code	Year	Scope	Law	Website
Regional waste management plan - Remediation of polluted areas (Piano regionale di Gestione dei rifiuti – sezione Bonifica delle aree inquinate)	RWMPPrpa	2018	The document includes information relating to the polluted areas, outlines the actions to be taken, defines the priorities of the actions, etc. The plan aims at recovering some areas of Sardinia, which show environmental issues.	Decision 1600/2002/EC, Directive 2004/35/EC, Directive 2008/98/EC, Italian Legislative Decree 22/1997, Italian Ministerial Decree 471/1999, Italian Law 97/2013, and others regulatory references	https://portal.sardegناسira.it/documents/21213/211487/09+Rapporto+Ambientale.pdf/a50b181d-16e5-4bbf-8808-0342230b2181
Regional cycling plan (Piano regionale della mobilità ciclistica della Sardegna)	RCP	2018	The plan proposes a regional cycling mobility system and identifies the cycle paths and the components of the system, which allow the cyclist to move from the places of arrival (ports and airports) to the internal and coastal areas of the island.	Italian Law 2/2018, Italian Law 366/1998, and others regulatory references	https://www.regione.sardegناسita.it/index.php?xsl=2425&s=386900&v=2&c=156&t=1&tb=13769
Management plan of Natura 2000 sites (Piani di gestione siti Natura 2000)	MPN2000s	Different years	The plans provide conservation objectives, and ecological needs of habitats and species.	Regulation (EU) 1303/2013, Directive 2009/147/EC, Directive 92/43/EEC, Italian law 157/1992, and others regulatory references	https://portal.sardegناسira.it/ricerca-sic-zps

3 **Table 2 Regional plans and programmes, whose SEA reports were selected in this study.**

Plans and SEA reports have been retrieved from the official web sites of the Autonomous Region of Sardinia. We aimed at providing the reader with the most complete sample of P/P accompanied by SEA report. The selected P/P regulate several activities at sub-regional scale and have effect on about 1.6 million people who reside in Sardinia. Most plans set a framework for local plans: the municipal administrations must draw up master plans consistent with principia and objectives included in the regional tools. This is relevant to promote at local level policies and strategies defined at national and European level, i.e., easing the mainstreaming of ACC according to a top-down approach.

As part of the analysis of the SEA reports, we also considered the Appropriate Assessment (AA), which was carried out for four plans. AA is a mandatory procedure for assessing if certain plans or projects have significant impacts on Natura 2000 sites (European Economic Community, 1992). The procedure is applied when plans and projects partially affect the areas included in the Natura 2000 network (Italian regulation, 1997). Then, we verified whether ACC has already been addressed in the definition of environmental protection policies of the regional Natura 2000 sites.

4.2. 4.2. Results

In Table 3, we report on the results of the application of our scrutiny. FRMP met four out of five criteria (CR1, CR2, CR3e, and CR4). WMP, REEP, and RDP met four criteria (CR1, CR2, CR3i, and CR4). RCP referred to four criteria as well (CR1, CR2, CR3e, and CR4). REFP included references to two criteria (CR3i and CR4). RWMPsw and RWMPrpa met only one criterion (CR2), while RWMPmw did not meet any criteria. As for the MPN2000s, the four SEA reports referred to three out of five criteria (CR2, CR3i, and CR4).

As a general overview, the selected SEA reports show a good attitude with respect to the integration of ACC concepts. Three criteria (CR2, CR3i, and CR4) are met in almost all the cases, while the other two (CR1 and CR3e) are satisfied in almost half of the items. CR1 has been met by five P/P, CR2 by eleven P/P, CR3e by two P/P, CR3i by eight P/P, and CR4 by ten P/P. CR2 shows the highest coverage rate, while CR3e the lowest one.

Plans and programmes (code)	Criteria				
	CR1	CR2	CR3		CR4
			CR3e	CR3i	
FRMP	✓	✓	✓		✓
WMP	✓	✓		✓	✓
REFP				✓	✓
REEP	✓	✓		✓	✓
RDP	✓	✓		✓	✓
RWMP _{mw}					
RWMP _{sw}		✓			
RWMP _{prpa}		✓			
RCP	✓	✓	✓		✓
MPN2000s “Altopiano di Abbasanta”		✓		✓	✓
MPN2000s “Altopiano di Campeda”		✓		✓	✓
MPN2000s “Campidano Centrale”		✓		✓	✓
MPN2000s “Capo Carbonara e stagno di Notteri - Punta Molentis”		✓		✓	✓

Table 3 Scrutiny of the SEA reports of regional plans and programmes (P/P).

The five most recent P/P refer to the European Strategy for Adaptation to Climate Change or the SNACC (FRMP, WMP, REEP, RDP, RCP). Then, less than half of the SEA reports are likely to be consistent with the principia of ACC (CR1). Eleven SEA reports include a climatic analysis (CR2), although it does not include: (i) current climatic trends or climatic emerging issues (for example, low rainfall combined with exceptionality of violent flood events), and (ii) a vulnerability assessment of the territory in terms of ACC. Two SEA reports explicitly refer to adaptation objectives (CR3e), which probably result from the contextualization of the adaptation objectives that emerged from the European and Italian ACC strategies. Most SEA reports define objectives that implicitly (CR3i) consider adaptation issues such as soil conservation, water management for containing hydrogeological instability processes, updating and integration of systems for acquiring weather-climatic data, protection of forest heritage, strengthen of civil protection system. Then, such objectives implicitly concur to increase the regional resilience. In some cases (see CR4), the SEA reports define (i) indicators for monitoring the implementation of interventions that can be considered adaptive (adaptive-like actions) (e.g., surface area subjected to hydraulic adjustments, number of awareness campaigns concerning environmental issues and adaptation to climate change) or (ii) indicators for monitoring the state of the environment in the context of climate change issues (e.g., average annual rainfall, maximum rainfall intensity in sixty minutes, ratio between water

requirements and overall water availability).

5. Discussion

We developed the case study in the Italian context, where the scientific panorama lacks published international research concerning ACC in sectoral P/P. According to the findings, most regional SEA reports do not refer to any adaptation strategies yet. The European and/or the national adaptation strategies are explicitly referred-to in the most recent SEA reports. As a matter of fact, mentioning the European and/or the national adaptation strategy in the regional tools could be considered the first step for introducing ACC considerations and principia in local plans. On the other hand, several SEA reports do not refer to any adaptation strategy and then the regional administration will have to proceed with proper adjustment and update. In fact, such SEA reports refer to P/P that define a framework for sub-regional planning tools (i.e. municipal masterplans) and the inclusion of clear references to adaptation strategies during the SEA process should increase the awareness on the need of ACC among planners, policymakers, and stakeholders.

Most SEA reports include the climate analysis, although it mainly refers to past weather events related to temperature and rainfall, while future trends and climatic scenarios received scarce consideration. This is a critical issue, as climate projections appear to be as basic elements for defining ACC strategies and actions. We did not investigate why the SEA reports are lacking in terms of future climate trends and scenarios. Since ACC has become a hot topic at national and regional scale only in recent years, we can assume that ACC was not acknowledged as relevant to the regional administration when the P/P were adopted. Furthermore, as Girvetz et al. (2009) point out, accessing to data concerning past climate and projected climate change can be difficult. We expect that regional authorities will disseminate updated meteorological data and climate projections at the regional and local scales and encourage the integration of climate analysis since the early stages of P/P elaboration.

Two SEA reports explicitly refer to climate change adaptation objectives and this is relevant to the integration of ACC considerations in P/P. According to Runhaar et al. (2018) (after Kok and De

Coninck (2007), Wamsler (2014), and Adelle and Russel (2013)), mainstreaming adaptation objectives into policies and plans could (i) contribute to achieve different goals, including the improvement of habitat quality and conservation of biodiversity, (ii) “be more resource-efficient” (Runhaar et al., 2018, p. 1201), according to an administrative perspective, and (iii) be key in terms of effective adaptation actions, although some critical issues are known in literature (for more details, see Runhaar et al., 2018). The mainstreaming of climate adaptation objectives into the regional P/P via SEA process should bring several benefits in the perspective of making the region more climate resilient. Eight P/P refer to implicit adaptation objectives, i.e. objectives that implicitly can contribute to increase the regional resilience, and might be entry points for specific tailored ACC objectives in future updates of P/P.

Finally, as part of the SEA follow-up most SEA reports include indicators for monitoring (i) the implementation of actions that can be considered adaptive and (ii) the state of the environment in the context of climate change issues. Such indicators should allow planners to assess the effectiveness of ACC measures defined in P/P. In the Italian context, and in Sardinia, the monitoring phase has been described as one of the main weaknesses in terms of SEA effectiveness (see De Montis, 2013; De Montis et al., 2014). In this study, we did not assess the quality and effectiveness of SEA monitoring but found out that several SEA reports comprehend indicators also useful for monitoring the effect of certain ACC measures, such as the efficiency of water distribution networks, forest cover, population exposed to landslides and flood risk, number of shading points on cycle paths, status indicators of naturalistic engineering measures, etc. Future studies may investigate the effectiveness of SEA monitoring, by considering if monitoring reports are periodically released, if the type and number of indicators are sufficient for the assessment of the effect due to P/P in terms of improvement of regional climatic resilience, and if sufficient resources are allocated for the SEA follow-up activities.

As a final remark, we compare the work developed in this paper with the exercise presented by Ledda et al. (2020), with respect to aims and findings. Ledda et al. (2020) started from the proposal

of a method for investigating regional spatial plans in Sardinia, with respect to the integration of ACC and found that recent planning tools contained explicit adaptation measures that could contribute to increasing territorial resilience. However, Ledda et al. (2000) did not provide any guidance and suggestions concerning the mainstreaming of ACC through SEA. By contrast, in this paper we moved from the proposal of a method able to support the mainstreaming of ACC considerations in regional planning and programming tools through the SEA process and obtained an overall picture of the interplay between SEA reports and ACC concepts and issues. In addition, the findings of this study have led to official tools -the SEA guidelines- which have been deliberated by the Autonomous Region of Sardinia in 2019 to steer the implementation of ACC through SEA in regional planning practice (Autonomous Region of Sardinia, 2019b).

6. Conclusions

This study deals with the consideration of adaptation to climate change (ACC) in strategic environmental assessment reports (SEA reports) of regional plans and programmes (P/P) in Sardinia (Italy). The Italian context is lacking in terms of research concerning the topic discussed in this paper and we aimed at filling up such a gap.

We found out that in Sardinia ACC is beginning to affect the SEA practice, and therefore the contents of the regional P/P, but not all the relevant ACC aspects are addressed exhaustively so far. In fact, most SEA reports, and respective P/P, need to be updated in terms of (i) consideration of climate trends and future climate scenarios, (ii) explicit adaptation objectives, and (iii) *ad-hoc* SEA monitoring indicators explicitly tailored to specific ACC measures.

We have proposed and applied a method rooted in scientific basis, which has allowed us to define five criteria to investigate if (and to what extent) SEA practice refers to ACC, and therefore if ACC is affecting P/P through the SEA process. The criteria can be included in the SEA report with the purpose of promoting ACC in the early stages of the planning process. If properly designed, the objectives of ACC can be consistent with sustainability principia that steer the SEA process. In other terms, once the environmental objectives are defined under the *aegis* of

environmental sustainability, SEA allows planners and decision makers to consider and define *ad-hoc* ACC objectives that are consistent with the sustainability principia. The set of criteria is rooted in European and Italian strategies for ACC and in considerations shared by many scholars. Then, we feel it can be applied in different geographical contexts, including other Italian regions and, if properly tailored (according to a context-specific approach), in other European regions. The method proposed in this study has been key in the drafting process of the SEA guidelines approved by the Autonomous Region of Sardinia as supplement of the regional adaptation strategy (RSACC). In particular, the results allow us to identify and suggest a set of recommendations for planners related to the main investigations that need to be considered during the elaboration of the SEA report, as specified in Table 4.

Focus	Description
Climate change policy	Analysis of the main objectives and targets relating to ACC and established by international, national or regional policies and strategies.
Risk, vulnerability and adaptive capacity	Analysis of environmental trends, current and past climatic conditions, and the main risks related to climate change for strategic sectors. Analysis of vulnerability and the assessment of the adaptive capacity.
ACC objectives and measures	Identification of objectives for specific strategic sectors of intervention.
Plan alternatives	Definition of some plan alternatives considering resilient scenarios with respect to the main criticalities linked to climate change.
Assessment of plan alternatives effects on the environment	Assessment of whether and how the implementation of the P/P could affect or be affected by climate change, also considering how climate change mitigation and adaptation interact with each other.
Identification of monitoring indicators	Identification of indicators describing the level of implementation of the ACC actions defined by the P/P, and the state of natural and non-natural resources after the implementation of the P/P (with a focus for the most vulnerable resources).

Table 4 Recommendations for the elaboration of the SEA report.

Below we stress the main limitations of this study. This research work focuses on a relatively small

set of SEA reports. Some regional P/P could not be considered, as they were approved without any SEA procedure, because a SEA regulation was not in force yet, or the planning process was already underway when SEA rules entered into force. Future research could be extended to a larger set of SEA reports, which include local plans, to compose a wider overview of the penetration of ACC concepts in the design of planning tools at a different scale. Another limitation of this study is connected to the small set of (five) criteria integrated in the assessment framework for evaluating the SEA reports. However, as already stated above, we decided to select a set of criteria broad enough to include many aspects related to ACC, in order to perform the analysis in a multisectoral planning context, in which these aspects are only recently starting to affect planning practice. We are aware that some other criteria could be used, such as the “provisions for monitoring climate-related measures [...] consultation with statutory consultees and the public that allows for climate change to be discussed” (Posas, 2011).

In further research studies, we will be analyzing the effect of public participation and collaboration of institutional bodies -with a focus on the environmental authorities- on integrating ACC issues in the drafting of planning documents and the SEA report.

Despite its limitations, this study provided the scientific debate with a contribution on a topical issue -i.e. the integration of ACC in planning and programming tools, which has not been sufficiently addressed so far. The methodological approach experimented in this work could be replicated by other scholars and extended to the study of different geographical and institutional contexts.

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