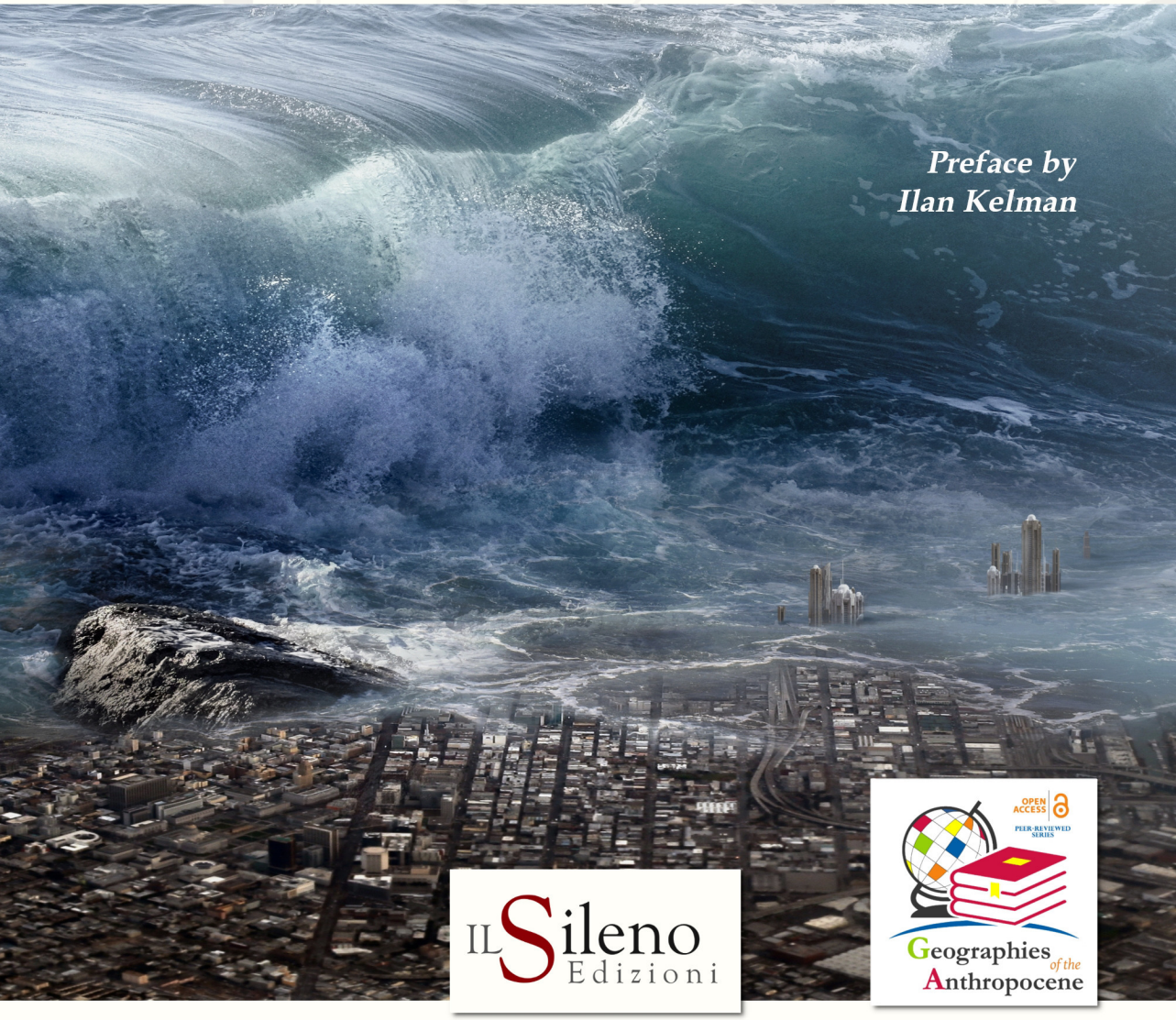
THE ANTHROPOCENE AND ISLANDS:

VULNERABILITY, ADAPTATION AND RESILIENCE TO NATURAL HAZARDS AND CLIMATE CHANGE

Miquel Grimalt Gelabert - Anton Micallef - Joan Rossello Geli
Editors

Preface by
Ilan Kelman



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Cover: imaginary representation of a tsunami that impacted an island. Source: pixabay.com

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Geographies of the Anthropocene

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Geographies of the Anthropocene

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The book series "Geographies of the Anthropocene", edited by the international scientific publisher "Il Sileno Edizioni", will discuss the new processes of the Anthropocene epoch through the various worldviews of geoscientists and humanists, intersecting disciplines of Geosciences, Geography, Geoethics, Philosophy, Socio-Anthropology, Sociology of Environment and Territory, Psychology, Economics, Environmental Humanities and cognate disciplines.

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CONTENTS

2. Large island, big issues. Vulnerability and resilience in Sardinia

Andrea Corsale[1], Carlo Perelli[2], Giovanni Sistu[3]

Abstract

Sardinia is the second largest island in the Mediterranean Sea. In recent decades, heated political, scientific and cultural debates have shown growing concern for coastal land consumption and produced increasing awareness and sensibility on effects due to vulnerability, risks and natural hazards. Approximately half of the Sardinian surface is considered vulnerable to current or future desertification processes. Wildfires, water consumption, urbanisation and land abandonment in declining rural districts, as well as overgrazing and farming intensification in other areas, are some of the major climate-related issues. Tourism activities, which are concentrated in time (summer) and space (coastline), strongly contribute to the regional system's vulnerability. In recent decades, inadequate policies and weak territorial planning have been observed even though climate and environmental issues are increasingly recognised as crucial elements for the future of the island. This article focuses on the local level by considering the formation and consolidation of the discursive practices of the protagonists in the regional debate. Government rationalities as well as rules and policies on prevention, mitigation and adaptation practices are relevant elements for the analysis. Development and planning strategies and practices, as well as relevant official documents, are also analysed and discussed.

Keywords: Sardinia; coastal tourism; depopulation; desertification; planning strategies.

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1. Introduction

In the past few decades, Sardinia has experienced remarkable socioeconomic transformation processes, which led to a considerable improvement in living conditions. These dynamics have also resulted in a substantial growth of environmental pressures on the island. One of the most important threats is the progressive settlement concentration of the regional population along the coasts; this phenomenon has occurred along with the growth of the industrial and tourism sectors and has been accompanied by the ongoing depopulation of the inland areas of the island. These changes have considerable negative effects on the rich natural heritage of Sardinia. Furthermore, inadequate policies, such as weak territorial planning and many contradictory measures, have been observed in many municipalities even though the precious environment of the island is widely recognised as one of the crucial elements for its future development perspectives. The recent decades have witnessed an interesting debate, which stems from widespread concerns about coastal land consumption and evolves towards the mitigation of vulnerability and risk assessment related to natural hazards.

The chapter individuates in a combination of human and climate-induced issues the main challenges for Sardinia in this phase. Suitable vulnerability assessment and adaptation measures to climate change are still necessary to advance in the search for proper management tools. The hypothesis discussed is that such unavoidable continuous progress, during the last decades, has sometimes been disregarded because of various factors. Probably the most relevant one was the ubiquitous request for policy measures aiming to generate fast economic growth through coastal urbanisation and tourism. The chapter describes the formation and consolidation of discursive practices among the protagonists of this conflict between visions and priorities. Starting from the description of the main variables, it focuses on the local debate, showing government rationalities as well as rules and policies on prevention, mitigation, and adaptation practices.

2. Population and settlement

With a surface area of 24,000 km^2, Sardinia is the second largest island in the Mediterranean Sea. However, it has a relatively low population density (less than 70 inhabitants per km^2), accounting for a little more than

1,630,000 residents. From a demographic point of view, the island is characterised by a progressive concentration of settlements and inhabitants along the coastline and around the main urban poles and by a gradually declining and ageing population (Corsale, 2016; Gentileschi, 1995). For most of its medieval and modern history, the island's population was largely distributed in the agropastoral inland areas, at a safe distance from the piracy- and malaria-infested coast (Casalis, 1833). The situation started to change in the late 19th century and in the second half of the 20th century with a reverse phenomenon of redistribution towards coastal and urban areas; this phenomenon further evolved into a considerable depopulation of mountain and hill settlements, a decrease in fertility rates and an ongoing urbanisation and littoralisation (Leontidou *et al*., 1997). Overall, the demographic framework of the island has shifted from an internal to a coastal population distribution, from intense natural increase to ageing and decline and from widespread emigration to immigration from abroad (Carboni and Fois, 2016; Corsale, 2016).

Thus, at the local level, population ageing and decline is particularly intense in most inland areas, whereas the urban clusters of Cagliari, Sassari and Olbia and several small settlements scattered along the coast still register feeble growth. These areas are characterised by the expansion of tertiary activities, including tourism, as well as the agricultural, industrial and construction sectors (Bottazzi, 1999; CRENoS, 2019). Sardinia appears to be increasingly and sharply divided into two main areas: (1) a coastal belt with a constant growth trend, which is more or less pronounced in different areas and (2) the rest of the territory, which is distant from the sea and mainly rural. In the latter, depopulation is intense, thus producing an overall ring-like pattern. Immigration tends to strengthen this trend, with most migrants concentrating in the most dynamic areas and sectors (Carboni and Fois, 2016). In accordance with the Italian Institute of Statistics, the Sardinian population is expected to decrease by 20% in 2050, with a significant population growth expected only in a few municipalities along the north-eastern coast and, to a lesser extent, in some suburban centres around Cagliari and Sassari, which are characterised by tertiary and industrial activities.

3. Climate

Sardinia's climate is typically Mediterranean and characterised by considerable seasonal differences and interannual variability. In the summer season, high pressure dominates the island, causing atmospheric stability which usually leads to hot, arid and subtropical weather conditions from June to August. In the winter season, high pressure cells move southwards and let humid air flows and cold polar fronts define autumn, winter and part of the springtime weather. The complex orography of the territory and the different exposure levels to winds generate numerous climatic microregions across the island (Motroni, 2016).

The Sardinian climatic conditions show signs of change, within broader trends and projections for the entire Mediterranean Basin (Navarra and Laurence, 2013). A substantial warming (up to 1.5°C in winter and 2°C in summer) and a considerable decrease in precipitation (up to -5%) may affect the region in the 2021-2050 period compared with the reference period (1961-1990) (Gualdi *et al*., 2012).

Recorded data from weather stations located evenly throughout Sardinia show a slight increase in temperatures, particularly for maximum values (+0.7°C), especially in coastal areas and some portions of the inland. Rainfall data show a progressive decrease but also a great variability in the amount of rain and occurrence of droughts. At the same time, the frequency of precipitation events of less than 5 mm has decreased, whereas rainfall of more than 50 mm has become more frequent (Motroni, 2016).

4. Growing vulnerability and poor planning

Sardinia has undergone wide transformations in the past 60 years. 'Modernisation' via the extraordinary financial intervention of the State and consequent public and private investments has led Sardinia to face a profound change in its structural socioeconomic conditions in the second half of the 20th century. Tourism specialisation and industrialisation concentrated in coastal areas have been the driving factors of a progressive littoralisation (Bottazzi, 1999; King, 1975; Ruju, 2018). In addition to social and economic changes, a radical transformation of the coastal landscape has been observed, with long-lasting and well-documented ecosystem impacts on air quality and common resources, such as soil and water (Aru *et al*., 1994; Cipriani, 2014; Leontidou *et al*., 1997; Pungetti, 1996; Stancampiano and Deliperi, 1993).

In recent years, the crisis of several large industries (particularly petrochemical and metallurgical industries based on lead-zinc and

aluminium) has led to a rapid decrease in employment and unsolved environmental problems (Balestrieri and Ganciu, 2018; Heatherington, 2001). Moreover, domestic and international tourism grew, especially in the 1960s, because of a consolidated image of a 'dream destination' fostered by relatively low population and soil consumption (Hospers, 2003; Price, 1983; Solinas, 1997).

Tourism development has produced a spatial concentration in the sandy coastal areas, with 90% of the hotel beds concentrated in the north-eastern, north-western, southern and central-eastern areas. Conversely, tourism seasonality is concentrated between June and September, accounting for approximately 80% of the overall tourism flow (Iorio and Sistu, 2004).

The prevalence of holiday houses over hotels has resulted in negative externalities on landscape, water resources, infrastructure congestion and waste production. Meanwhile, inadequate tourism management and planning strategies have resulted in poor integration between environmental protection and local economy (CRENoS, 2019).

Only at the end of the 1980s did a relatively innovative institutional approach produce the first regional laws on urban planning, quarrying activities and protected areas.

However, the vast network of protected areas envisioned by the Regional Law 31/1989 remained largely ineffective, as national, regional and marine parks have been established in coastal areas, whereas the internal areas remain largely uncovered due to widespread opposition stemming from local stakeholders, such as shepherds and hunters. Such is the case of the Gulf of Orosei-Gennargentu National Park, which was formally established in 1998 to protect some of the most fragile and precious mountain ecosystems of the island, but has never been carried out in practice.

A potentially innovative approach, which aims to integrate nature conservation, heritage promotion and local development, resulted in the establishment of the Geo-mining Historic and Environmental Park of Sardinia in 2001 (approximately 37,500 ha distributed in eight different coastal and inland areas). However, the project has produced limited benefits due to territorial fragmentation, administrative difficulties and the costly and complex rehabilitation of polluted former mining sites (Perelli and Sistu, 2010).

5. Overturning the inertia: the 2006 PPR

The first large-scale attempt to introduce a new approach to planning issues mainly focused on coastal areas. The so-called Save Coast Law (2004) and the subsequent Landscape Plan (PPR) aimed to deal with the contradictory effects of combined tourism development and littoralisation. The history of tourism in Sardinia saw a pioneering phase of international tourism development in Alghero in the mid-1950s, followed by an international consortium which invented and created the renowned Costa Smeralda resort area in the 1960s. From that moment, often on the impulse of foreign capital, a ubiquitous real estate development resulted in a chaotic geography of new tourist centres, which were also sustained by the growing Sardinian middle class (Price, 1983).

Despite some attempts to introduce coastal conservation measures (e.g. the prohibition to construct new buildings within 150 metres from the coastline, 1976), various municipalities proposed new coastal settlement plans for approximately 10 million m^3 in the mid-1970s (Roggio, 1995; 2007). The growth rate of the holiday home sector in Sardinia exceeded 400% between 1970 and 1980. During the 1980s, the Sardinian Regional Authority and the private Costa Smeralda consortium agreed upon further real estate investments for approximately 6 million m^3; such investments mainly included holiday homes and villas in the north-eastern coastline of Arzachena, although a judicial conflict between the local municipality and the Regional Authority blocked the implementation of this master plan in 1988 (Roggio, 2007). In the town of Olbia, a consortium led by Silvio Berlusconi promoted new settlements for over 20,000 beds and, in 1983, the municipality adopted a regulation granting them over 1.2 million m^3.

In 1985, the Sardinian Regional Authority appointed several technical groups to elaborate renewed territorial plans, which are consistent with the new environmental conservation philosophy supported by the 'Galasso' national law. However, the results appeared unable to manage and curb the ongoing occupation of the coastal belt. After several years of discussion (1993-2003), the ruled illegitimacy of 13 out of 14 proposed territorial plans finally highlighted the failure of these attempts to implement coastal planning tools (Falqui, 2011). In a vacuum of protection measures, the so-called Save Coast Law introduced 'Urgent provisional safeguard rules for landscape planning and the protection of the regional territory' in 2004. These rules included a general prohibition to build new real estates within 2000 m from the coastline. The law, which is unique in the entire Mediterranean region, affirmed the priority of environmental protection over building development, in spite of persistent pressures linking tourism development to real estate development, and anticipated the vision of the

latter Regional Landscape Plan (*Piano Paesaggistico Regionale* or PPR) (Perelli, 2016).

Although the PPR does not cover the entire regional territory, it is a pioneering experience in Italy because it is the first plan which implemented the provisions of the law for Cultural Heritage and Landscape focusing essentially on the coastline. The PPR started a new era of regional plans, attempting to integrate long-lasting ecological and symbolic relations between human communities and territories.

On the contrary, some authors (Leone and Zoppi, 2016) highlighted criticism on the effectiveness of the participation processes established by the PPR, which affected the capability of the municipalities' plans to adjust to it. A lack of dialogue and understanding amongst stakeholders on the planning issues can be a serious threat when emerging complex phenomena related to climate change have to be faced; moreover, the regional and local levels need to develop stronger consensus processes (De Montis *et al*., 2018a).

6. Soil use and forest cover

Soil loss largely depends on wildfire occurrence, poor management of mining activities, road and railway infrastructure and urban expansion. With respect to soil protection, Sardinia can account for a detailed inventory provided by the *Soil Map of Sardinia* (Aru *et al*., 1991). On the one hand, indicators show that soil consumption for industrial use, service infrastructure and urban expansion is considerable in the major urban areas (Cagliari, Sassari, Oristano, Nuoro, Olbia, Alghero). On the other hand, urban sprawl significantly affects many coastal areas and the main road axes. Strong coastal pressure (particularly in the Gallura subregion) is currently associated with the urban expansion of inland municipalities near coastal tourism areas, where urban planning tools, such as the PPR, have less effect. In the same years, data from the national forest inventory (INFC, 2007) show that Sardinia is the Italian region with the largest forest cover, accounting for 1,213 ha (583 ha of proper forest and 630 ha of other wooded areas).

Despite some issues related to the legal status of forest and wooded areas and recurrent wildfires, widespread reforestation occurred since the 1950s and public forestry management considerably increased the forest cover in Sardinia in comparison with the levels of the early 1900s. Between the 1950s and the 1970s, reforestation accounted for approximately 1,500 ha

yearly. The subsequent state-funded productive forestry sector managed more than 30,000 hectares until the end of the 1980s. The EU-funded reforestation policies in agricultural areas produced further results in the 1990s, with new wooded areas estimated between 18,000 and 20,000 ha. In recent years, the crisis of sheep and goat farming resulted in a natural recolonisation of abandoned pastures, contributing to an additional increase in wooded surface (Beccu, 2000; Puddu *et al*., 2012). The key elements that mainly influence the success of public policies on forestry are, not only the still relatively widespread public ownership of the land and the consequent customary rights to forest use, but also the economic relevance of public forestation managed by the regional agency (*Forestas*). These two themes are linked, for instance, to the integrated management of protected areas and the innovative management of summer wildfires. Since the 1990s, Sardinia has managed to reduce burnt surfaces progressively through law enforcement and prevention activities, although meteorological trends affect the predictability of seasonal fires (RAS, 2020).

7. After the PPR: coping with vulnerability

At present, approximately 50% of the Sardinian surface is vulnerable to potential desertification processes because of climate change and variability. The main factors of desertification phenomena in Sardinia include extreme climatic events (droughts and floods), human pressure (overgrazing, urbanisation, pollution and depopulation of rural districts), excessive exploitation of water resources, wildfires and deforestation (Arrigoni, 1968; Camarda and Cossu, 1988; Vacca and Vacca, 2001). Soil erosion, compaction, consumption and sealing are common degradation processes in rural areas and result in a loss of ecological value and functions (Vacca, 2000). The Sardinian Regional Authority has been collecting data on desertification processes since 2002 to model them. A GIS application maps areas of sensitiveness and critical districts on a local level, where desertification signs are already observable[4] (Motroni *et al*., 2009).

[4] At the end of the 1990s, a shared vision at the continental level was adopted on the basis of the ESA model through the European project MEDALUS II; this vision is an articulate approach encompassing the entire biophysical processes that contribute to desertification.

Climate variations directly affect the availability of water resources by reducing the stock of surface reservoirs and threatening the quantity and quality of groundwater, especially during extended periods of drought (e.g. between 1997 and 2000). Given poor urban planning and insufficient maintenance of water networks, an increased occurrence of floods can be particularly destructive; several major events have already occurred in the past decades (e.g. in 1951; 1999; 2008; 2013; accounting for 19 deaths and 2018) (Silvano, 2016; Sulis *et al*., 2020). Wildfires, excessive water consumption, land abandonment in rural districts formerly exploited for agricultural or breeding activities, and farming intensification and overgrazing in other areas, are amongst the major climate-related threats in the island (Le Lannou, 1941; Manconi and Angioni, 1982; Mientjes, 2004).

Concerning wildfires, the areas which kept the same land use type counted 39,621 wildfires between 2000 and 2015 (Bajocco *et al*., 2019). The land cover type was a relevant variable with arable land and permanent crops experiencing an increase in fires, and mixed agriculture, maquis, and forests showing a considerably decreasing trend over the period. During four decades, cross-studies on demographic trends and land use proved that the areas where population grows tend to show increasing fire ignition energy. On the other hand, however, depopulated areas, while experiencing a reduction of wildfires in the short term, also show significant long-term threats due to the amassing of fuel (Bajocco *et al*., 2019). A recent study illustrates that, in the cork oak production areas, about 15,500 hectares burned in the period 2003-2015, which is particularly worrying, as Quercus suber L. woodlands are a key historical agroforest resource and are essential in keeping high soil quality standards (Salis *et al*., 2019).

Regarding land consumption, Sardinia shows good performances if compared with the rest of Italy. This is mainly due to the previsions of the Regional Landscape Plan of 2006. The latest data available (Munafò, 2020), for instance, show little less than 80,000 ha of urbanized land in Sardinia in 2019, meaning 3.2% of the island surface (7.1% at the national scale). Consumed surfaces amounted to 165 ha during 2019, among which 90 for new photovoltaic plants installed on the ground in the municipalities of Uta (60.2 ha), and Assemini (30.2). Furthermore, in 2019, the percentage of land consumed within 150 m from water bodies amounted to 2.9%, much lower than the national average of 7.1%, and its variation during 2019 was even negative (-1.8 ha), compared to a national increase of 58.2 ha. Urbanization

is a significant factor in the alteration of microclimates at the local level, resulting in sizeable temperature increase in artificially covered lands (Munafò, 2020).

Soil protection is closely related to the topic of landscape planning. Several regional land management policies, as well as those of the related sectors, have not paid enough attention to these issues. Many key documents, such as the map of hydrogeological risk, the hydrogeological plan (PAI) and the transitional plan for fluvial belts (PSFF), have not been adequately implemented. The National Government Bill principles (2013), which deal with the containment of land loss and the reuse of built soil, have yet to be introduced in the regional legislation. In particular, the PAI is a fundamental tool because it identifies risk areas for floods and landslides in accordance with the provisions of law 267/1998.

Year	***Document***	***Functions***
1990	Soil Map of Sardinia 1:250,000	Soil classification by classes of potential use
2006	Regional Landscape Plan (*PPR*)	Coastal planning and ecosystem protection
2006	Hydrogeological Framework Plan (*PAI*)	Classification by risk classes of hydraulic and landslide hazard areas, mitigation and risk control
2010	River Basin Management Plan (*PGDI*)	Delimitation of river basins to allow for a water regime which is compatible in terms of safety and eco-systemic balance
2015	Regional Environmental Energy Plan (*PEAR*)	Regional energy plan related to European and national guidelines for energy transition
2016	Flood Risk Management Plan (*PGRA*)	Planning and implementation measures to reduce the consequences of floods
2019	Regional Strategy for Adaptation to Climate Change (*SRACC*)	Planning tools for the development of effective adaptive strategies
To be defined	Regional Strategy for Sustainable Development (*SRSvS*)	Path for the implementation of the '17 Sustainable Development Goals of the 2030 UN Agenda'

Tab. 1 – *Chronology of relevant planning documents.*

The Sardinian Regional Government approved a River Basin Management Plan in 2010 (which is currently being updated) as a monitoring tool for water bodies (RAS, 2010). It identifies the main groundwater bodies in use and contributes to define integrated water management strategies. As surface and groundwater resources are part of an interconnected system, including wastewater, further coordination amongst

all stakeholders is imperative. The worsening of the quality of water supply implies additional safeguard policies for the aquifers together with more immediate surface water management actions. From this perspective, the management of interconnected water systems, such as those developed around dams, can be considered an effective adaptation policy. According to demand needs, it allows a flexible adaptation to emergency supply or restrictions in case of droughts (Cadoni, Silvano and Virdis, 2011). The plan provides a framework for the integration of alternative resources and the combined use of different water sources. Furthermore, it adopts adaptation measures that support weather and climate data improvement, drought monitoring and guidelines to improve water use in agriculture. The Sardinian experience shows that water shortage management on a long temporal scale reduces the negative effects on the economic system in comparison with less effective emergency actions that target a single extreme water shortage. Reinforcing the ongoing IT-based decision support system can help improve adaptation to extreme weather through a rational use of resources, thereby minimising hydrological risks.

The Regional Environmental Energy Plan (*PEAR*) (RAS, 2015) was approved in 2015, envisioning the year 2020 as a deadline to define effective measures for energy use efficiency, emission reduction and the consolidation of alternative source production. In January 2019, a first monitoring report was published, assessing the results attained by the *PEAR* measures[5]. The recent approval of the plan has not led to radical changes in the island's energy system. With respect to the purpose of 50% reduction in CO_2 emissions by 2030, and in comparison with the 1990s values, the report states that emissions were reduced by approximately 25% in 2017. By maintaining this rate of reduction, the goal will be achieved by 2030. General objectives, such as the transition towards an integrated energy system (OG1) and the promotion of research and participation in the energy field (OG4), appear to be advancing. By contrast, the energy security objective (OG2) seems to be less advanced because of delayed works for methanisation and a difficult transition from fossil sources. Improved results emerge with respect to the flexibility of the electrical energy system and the diffused generation from renewable sources for self-consumption. Lastly, the increased efficiency and the objective of energy saving (OG3) is advancing because of integrated network development, particularly in the

[5] www.regione.sardegna.it/documenti/1_461_20190402172259.pdf

transportation sector. Meanwhile, actions for energy efficiency in the electrical and thermal sectors remain underdeveloped.

The Flood Risk Management Plan approved in 2016 is currently being updated according to the Directive 2007/60/CE (the second planning cycle is 2016-2021). In this phase, simulation models are being developed, focusing on basin vulnerability to flood damages and assessing alternative strategies to mitigate the effects of floods (Sulis *et al*., 2020).

A recent EU-funded project has been contributing to define the strategic guidelines followed during the elaboration of the Regional SRACC in 2019[6]. The main idea was to create a collaborative process between authorities, agencies and other decision-makers at the municipal and regional scale. The strategy is grounded in a detailed preliminary study conducted by the University of Sassari (RAS, 2019a). It focuses on key domains (agroforestry, water management and hydrogeological risk control) affected by weather variability and anthropogenic pressures and is distinguished for the existence of planning tools and skills for the development of effective adaptive strategies. Consequently, the strategies and actions for adaptation identified by the Regional SRACC essentially coordinate the already existing plans and tools that cope with adaptation issues. The PPR, PAI, PGRA and PSFF already provided implicit and explicit adaptation measures, which vary from studies or monitoring to effective defensive works to reduce territorial vulnerability (RAS, 2019b).

The strategy is envisaged as a transversal framework that is oriented to highlight the deficiencies of sectoral planning and makes its objectives congruent with adaptation priorities rather than reform each specific domain directly. It implies confidence that the existing framework and skills can be optimised with minor revisions. Furthermore, it tends to reduce or avoid power conflicts related to any possible changes in the balance of consolidated political and technical skills at the regional level. In this sense, the attribution of the main coordination functions to the Department of Defence of the Environment could likely represent an opportunity for the effective implementation of the actions descending from the proposed sectoral objectives. However, this process may eventually result in the emergence of new controversies amongst various stakeholders, similarly to what had already happened in the past in these domains. For example, general objectives, strategic axes of action and adaptation priorities (either incremental, systemic or transformative) should be based on transversal or

[6] Life project MASTER Adapt (Main Streaming Experiences at Regional and local level for adaptation to climate change) (Master Adapt, 2018).

sectoral shared and participative approaches. However, their monitoring is entrusted to a pyramidal management system, which limits effective participation.

Topic	Governance and adaptation to climate change
Tools	Online questionnaires Analysis to official website and documents Analysis of regional plans
Criteria	Adaptation Strategies reference Adaptation measures Implicit or explicit measures Responsible for the identified adaptation measures

Tab. 2 - Methods and tools adopted for investigating the current regional governance of climate change adaptation and criteria selected for analysing the plans in the Regional Strategy for Adaptation to Climate Change. Source: modified from De Montis *et al*. (2018a).

8. Resilience between rhetoric and policies

The integration of the resilience paradigm in the planning strategy envisioned by the SRACC reveals a contrast between scientific awareness of the emerging scenarios and the fragility of institutional action. The decision support document elaborated by the University of Sassari outlines an integrated system that copes with complexity and uncertainty. By contrast, a lack of elasticity of the settlement model and related economies resulted in a continuous delay in considering climate change as an immediate priority. However, in this context, resilience practices emerge at the local scale (interestingly more frequent in critical socio-demographic situations) and in some important natural ecosystem components, such as forest cover. Resilience-building actions also appear in sectoral interventions in strategic policy areas, such as energy transition, urban planning, reduction of summer wildfires, water resource management policies, waste production reduction and integrated management. Essentially, the sectoral impact chain at the regional level develops through

four stages: risk recognition, source identification, vulnerable elements detection and adaptation capacity analysis (RAS, 2019a). Yet, several implementation fittings are advisable, such as wider transversal strategies, new technologies to improve high resolution territorial information systems, smoother and more inclusive public administration procedures, and further investments on education and awareness both for the general public and the specific stakeholders. For example, regarding the hydrogeological risk, red tape hurdles, inadequate monitoring and insufficient awareness among the population, in terms of behavioural impacts, are significant threats, but also show wide margins for improvement. In fact, so far, many actions still do not appear organically inserted in medium- and long-term political strategies, which are still conditioned by the need to maintain political consensus in the short term. Therefore, at the local scale, without awareness and involvement, the inhabitants can hardly act as holders of rights and responsibilities. Moreover, they can hardly activate constructive participatory policies that go beyond a lobbying approach by the most important stakeholders or a consensus-building strategy. Hence, the policy strategies ought to become a key reference for the Regional Operative Plan 2021-2027, and its implementation should probably become a direct competence of the Regional Presidency, the only authority able to effectively address the institutional actions and the common practices. Resilience, as an operational paradigm, can thus allow local actors to face regional system vulnerabilities by recognising and placing specificities and locally based solutions for local development.

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References

Arrigoni, P.V., 1968, "Fitoclimatologia della Sardegna", *Webbia*, 23, 1, 1-100. Doi:10.1080/00837792.1968.10669879.

Aru, A., Baldaccini, P., Vacca, A., 1991, "*Nota illustrativa alla carta dei suoli della Sardegna, Regione Autonoma della Sardegna, Cagliari*", http://www.sardegnaportalesuolo.it/sites/default/files/documenti/nota_illustrativa_alla_carta_dei_suoli_della_sardegna.pdf, last access: 23/10/2020.

Aru, A., Enne, G., Pulina, G. (Eds.), 1994, "*Land Use and Soil Degradation. Medalus in Sardinia*". Proceedings of the Conference held in Sassari, Italy, 25 May 1994, Alghero.

Bajocco, S., Ferrara C., Guglietta D., Ricotta C., 2019, "Fifteen years of changes in fire ignition frequency in Sardinia (Italy): a rich-get-richer process", *Ecological Indicators*, 104, 543-548. Doi:10.1016/j.ecolind.2019.05.030.

Balestrieri, M., Ganciu, A., 2018, "Landscape Changes in Rural Areas: A Focus on Sardinian Territory", *Sustainability*, 10, 123. Doi:10.3390/su10010123.

Beccu, E., 2000, *Tra cronaca e storia, le vicende del patrimonio boschivo della Sardegna*, Carlo Delfino Editore, Sassari. (http://www.sardegnaambiente.it/documenti/3_66_20060609115059.pdf), last access: 23/10/2020.

Bottazzi, G., 1999, *Eppur si muove! Saggio sulle peculiarità del processo di modernizzazione in Sardegna*, CUEC, Cagliari.

Cadoni, D., Silvano, R., Virdis, A., 2011, "*Drought Watch System in Sardinia to Reduce Supply Vulnerability and Improve Water Resources Management During Periods of Drought*", WasserMed Project, Workshop on water-related security threats in Sardinia, Cagliari.

Camarda, I., Cossu, A. (eds.), 1988, *Biotopi di Sardegna: Guida a dodici aree di rilevante interesse botanico*, Carlo Delfino Editore, Sassari.

Carboni, M., Fois, M., 2016, "The Foreign Presence in Sardinia". In: Corsale, A., Sistu, G. (eds.), *Surrounded by Water. Landscapes, Seascapes and Cityscapes of Sardinia*, Cambridge Scholars Publishing, Newcastle, 99-111.

Casalis, G., 1833, *Dizionario geografico storico-statistico-commerciale degli Stati di S.M. il Re di Sardegna*, Maspero e Marzorati, Turin.

Cipriani, L.E., 2014, *Coastal erosion monitoring. A network of regional observatories. Results from ResMar Project*, Nuova Grafica Fiorentina, Florence.
(https://www.regione.toscana.it/documents/10180/320308/Coastal%20erosion%20monitoring/cd90e6ac-2518-40b0-b219-57dafcdecc98), last access: 23/10/2020.

Corsale, A., 2016, "Demographics of Sardinia. Main Features and Trends". In: Corsale, A., Sistu, G. (eds.), *Surrounded by Water. Landscapes, Seascapes and Cityscapes of Sardinia*, Cambridge Scholars Publishing, Newcastle, 64-81.

CRENoS, 2019, "*XXVI Rapporto sull'Economia della Sardegna*", (https://crenos.unica.it/crenosterritorio/sites/default/files/allegati-

pubblicazioni-
tes/26%20%C2%B0%20Rapporto%20CRENoS%20sull%27Economia%20della%20Sardegna.pdf), last access: 23/10/2020.

De Montis, A., Ledda, A., Di Cesare, E.A., Satta, G., 2018a, "Governance and adaptation to climate change. An investigation in Sardinia". In: Leone A., Gargiulo C. (Eds.), *Environmental and territorial modelling for planning and design*, FedOAPress, Naples, 52-55.

De Montis, A., Di Cesare, E.A., Ledda A., Trogu, D., Campagna, M., Cocco, G., Satta, G., Marcus, A., 2018b, "Integrating climate change adaptation into SEA. An assessment for Sardinia, Italy". In: Leone A., Gargiulo C. (eds.), *Environmental and territorial modelling for planning and design*, FedOAPress, Naples, 215-221.

Falqui, P., 2011, "La vicenda paesistica in Sardegna: dalla Legge Galasso all'annullamento dei PTP (1985-2003)", *Gazzetta Ambiente*, 17, 6, 11-28.

Gentileschi, M.L., 1995, "The population of Sardinia. Recent changes in distribution". In: Carli M.R. (ed.) *Economic and population trends in the Mediterranean islands*, Edizioni Scientifiche Italiane, Rome, 35-57.

Gualdi, S., and co-authors, 2012, "The CIRCE simulations: a new set of regional climate change projections performed with a realistic representation of the Mediterranean Sea", *Bulletin of the American Meteorological Society*, 94, 65-81. Doi: 10.1175/BAMS-D-11-00136.1.

Heatherington, T., 2001, "Ecology, alterity and resistance in Sardinia", *Social Anthropology*, 9(3), 289-306, doi:10.1017/S0964028201000222.

Hospers, G.J., 2003, "Localization in Europe's Periphery: Tourism Development in Sardinia", *European Planning Studies*, 11, 6, 629-645. Doi:10.1080/0965431032000108369.

INFC, 2007, *Le stime di superficie 2005. Prima parte. Inventario Nazionale delle Foreste e dei Serbatoi Forestali di Carbonio*, MiPAAF, Ispettorato Generale Corpo Forestale dello Stato, CRA-MPF, Trento.

Iorio, M., Sistu, G., 2004, "Turismo, comuni costieri e pressione ambientale". In: Cao, D., Usai, S. (eds.), *Economia del turismo in Sardegna*, CUEC, Cagliari, 49-76.

King, R., 1975, *Sardinia*, David & Charles, Newton Abbot.

Le Lannou, M., 1941, *Pâtres et paysans de la Sardaigne*, Arrault, Tours.

Leone, F., Zoppi, C., 2016, *Participatory processes and spatial planning: the Regional Landscape Plan of Sardinia*, Italy, FrancoAngeli, Milan.

Leontidou, L., Gentileschi, M.L., Aru, A., Pungetti, G., 1997, "Urban expansion and littoralisation". In: Mairota, P., Thornes, J.B., Geeson, N. (eds.), *Atlas of Mediterranean Environments in Europe*, Wiley, Chichester, 92-97.

Manconi, F., Angioni, G. (eds.), 1982, *Le opere e i giorni: Contadini e pastori nella Sardegna tradizionale*, Silvana Editoriale, Milan.

Master Adapt, 2018, "*Main Streaming Experiences at Regional and local level for adaptation to climate change*", retrieved from https://masteradapt.eu., last access: 23/10/2020.

Mientjes, A., 2004, "Modern pastoral landscapes on the island of Sardinia (Italy). Recent pastoral practices in local versus macro-economic and macro-political contexts", *Archaeological Dialogues*, 10, 2, 161-190. Doi:10.1017/S1380203804001230.

Motroni, A., 2016, "Climate, Climate Change and Desertification". In: Corsale, A., Sistu, G. (eds.), *Surrounded by Water. Landscapes, Seascapes and Cityscapes of Sardinia*, Cambridge Scholars Publishing, Newcastle, 27-34.

Motroni, A., Canu, S., Bianco, G., Loj, G., 2009, "Monitoring Sensitive Areas to Desertification in Sardinia: The Contribute of the Regional Agrometeorological Service". In: Marini, A., Talbi, M. (eds.), *Desertification and Risk Analysis Using High and Medium Resolution Satellite Data*, Springer, Dordrecht, 117-128.

Munafò, M. (ed.), 2020. "*Consumo di suolo, dinamiche territoriali e servizi ecosistemici. Edizione 2020*". Report SNPA 15/20, https://www.snpambiente.it/2020/07/22/consumo-di-suolo-dinamiche-territoriali-e-servizi-ecosistemici-edizione-2020/, last access: 23/10/2020.

Navarra, A., Laurence, T., 2013, "Regional Assessment of Climate Change in the Mediterranean", *Advances in Global Change Research*, 50, Springer, Dordrecht.

Perelli, C., 2016, "Coastal Planning and Tourism Development. Reframing Seaside Paradise". In: Corsale, A., Sistu, G. (eds.), *Surrounded by Water. Landscapes, Seascapes and Cityscapes of Sardinia*, Cambridge Scholars Publishing, Newcastle, 142-154.

Perelli, C., Sistu, G., 2010, "Abitare il tempo… libero. Il sogno proibito del turismo minerario in Sardegna". In: Iorio, M., Sistu, G. (eds.), *Dove finisce il mare*, Sandhi Editore, Cagliari, 361-374.

Price, R.L., 1983, *Una geografia del turismo: paesaggio e insediamenti umani in Sardegna*, Formez, Cagliari.

Puddu, G., Falcucci, A., Maiorano, L., 2012, "Forest changes over a century in Sardinia: implications for conservation in a Mediterranean hotspot", *Agroforestry Systems*, 85, 319-330. Doi:10.1007/s10457-011-9443-y.

Pungetti, G., 1996, *Landscape in Sardinia: History Feature Policies*. CUEC, Cagliari.

Pungetti, G., 2003, “Ecological landscape design, planning and connectivity in the Mediterranean and in Italy”. In: Mora, M.R.G. (ed.) *Environmental Connectivity: Protected Areas in the Mediterranean Basin*, Junta de Andalucia, RENPA and IUCN, Seville, 109-120.

RAS, 2010, “*Piano di bacino del distretto idrografico della Sardegna*”, www.regione.sardegna.it/autoritadibacino/pianificazione/, last access: 23/10/2020.

RAS, 2015, “*Piano energetico ambientale della Sardegna*”, www.regione.sardegna.it/documenti/1_274_20160129120346.pdf, last access: 23/10/2020.

RAS, 2019a, “*Metodi e strumenti per la Strategia regionale di adattamento ai cambiamenti climatici*”, https://delibere.regione.sardegna.it/protected/45525/0/def/ref/dbr45368/, last access: 23/10/2020.

RAS, 2019b, “*Strategia regionale di adattamento ai cambiamenti climatici*”, https://delibere.regione.sardegna.it/protected/45523/0/def/ref/dbr45368/, last access: 23/10/2020.

RAS, 2020, “*Prescrizioni antincendio 2020-2022*”, www.sardegnaambiente.it/index.php?xsl=612&s=408169&v=2&c=4507&t=1, last access: 23/10/2020.

Roggio, S., 1995, *Le ultime spiagge*, Alinea, Florence.

Roggio, S., 2007, *C’è di mezzo il mare: le coste sarde, merci o beni comuni?*, CUEC, Cagliari.

Ruju, S., 2018, *L'irrisolta questione sarda. Economia, società e politica nel secondo Novecento*, CUEC, Cagliari.

Salis, M., Arca, B., Alcasena-Urdiroz, F., et al., 2019, “Analyzing the recent dynamics of wildland fires in Quercus suber L. woodlands in Sardinia (Italy), Corsica (France) and Catalonia (Spain)”, *European Journal of Forest Research*, 138, 415-431. Doi:10.1007/s10342-019-01179-1.

Silvano, R., 2016, “Water management: reducing vulnerability and improving management during periods of drought”. In: Corsale, A., Sistu, G. (Eds.), *Surrounded by Water. Landscapes, Seascapes and Cityscapes of Sardinia*, Cambridge Scholars Publishing, Newcastle, 256-271.

Solinas, G.A., 1997, *Un’isola di vacanze. Per una storia critica del turismo in Sardegna*, EDES, Sassari.

Stancampiano, P., Deliperi, S., 1993, “Coste, Piani Paesistici e Turismo”. In: Tsetsi, V., Cirronis, I. (eds.). *Ambiente e sviluppo sostenibile Il caso Sardegna*, CUEC, Cagliari, 109-119.

Sulis, A., Frongia, S., Liberatore, S., Zucca, R., Sechi, G.M., 2020, "Combining water supply and flood control purposes in the Coghinas Basin (Sardinia, Italy) ", *International Journal of River Basin Management*, 18, 1, 13-22. Doi:10.1080/15715124.2018.1476366.

Vacca, A., 2000, "Effect of land use on forest floor and soil of a Quercus suber L. forest in Gallura (Sardinia, Italy)", *Land Degradation and Development*, 11, 167-180.

Vacca, A., Vacca, S., 2001, "Soil degradation in Sardinia - Historical causes and current processes due to anthropogenic pressure", *Petermanns Geographische Mitteilungen*, 14, 68-78.

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