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In the heart of Sicily: a renewed approach to knowledge to solve the complex relationship between Sicani Natural Park and its community

Nel cuore della Sicilia: un rinnovato approccio alla conoscenza per risolvere il complesso rapporto tra il Parco Naturale dei Sicani e la sua comunità

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ABSTRACT AND KEYWORDS

In the heart of Sicily

After a forty-year-long period of reflections and applications in an innovative approach to heritage protection and landscape quality management and development, the European Landscape Convention (Council of Europe, 2000) calls for "a sustainable development based on a balanced relationship between social needs, economic activity, and the environment". Starting from an articulated theoretical review on the topics of cultural heritage-based development, landscape quality and land protection as community assets, the paper is focused on the identification of strategies and actions to solve the conflicts that in recent years in inner western Sicily have blocked the Sicani Natural Park Agency, in preparing consultation between the Park Authority and local communities to design the new Park Plan.

The study has as a result a synoptic picture to face the challenge of territorial and social regeneration, to enhance the presence of an unspoilt natural heritage, and trigger the local resources-based development, counteracting the economic and demographic discomfort. The research results grasp all the facets of individual issues and propose the most appropriate options, proposing local solutions that promote protection and development.

Keywords: cultural heritage, nature protection, soil consumption, landscape, community

Nel cuore della Sicilia

Dopo quarant'anni di riflessioni e applicazioni in un approccio innovativo alla protezione del patrimonio, alla gestione e allo sviluppo della qualità del paesaggio, la Convenzione europea del paesaggio (2000) chiede che "uno sviluppo sostenibile basato su un rapporto equilibrato tra bisogni sociali, attività economica e ambiente". A partire da un'articolata rassegna teorica sui temi dello sviluppo basato sul patrimonio culturale, qualità del paesaggio e protezione del territorio come beni comunitari, il documento si focalizza sull'individuazione di strategie e azioni per risolvere i conflitti che negli ultimi anni nell'interno della Sicilia occidentale hanno bloccato, più volte, l'istituzione del Parco Regionale dei Monti Sicani, e per preparare l'Ente Parco alla consultazione con le comunità locali e alla progettazione del nuovo Piano Parco.

Lo studio ha come risultato un quadro sinottico mirato ad affrontare la sfida della rigenerazione territoriale e sociale, a implementare il ruolo della presenza di un patrimonio naturale incontaminato, e a innescare uno sviluppo autosostenibile basato sulle risorse endogene, contrastando il disagio economico e demografico. I risultati della ricerca colgono tutte le sfaccettature dei singoli temi e propongono le opzioni più appropriate, proponendo soluzioni locali che promuovano protezione e sviluppo.

Parole chiave: patrimonio culturale, tutela, consumo di suolo, paesaggio, comunità

1. Research issues

Cultural heritage and landscape are essential components of local development policies. Protected areas and natural parks represent the core of a holistic and systemic approach where protection and transformation, sustainable development, and respect for cultural heritage and biodiversity are interconnected.

However, many local communities do not fully embrace the mandatory protection of cultural heritage, landscapes, and soil as foundational assets for sustainable development. This resistance is particularly evident in many areas of southern Europe, where the high density of heritage resources creates conflicts between uncontrolled transformation and legal protection (Angelini & Pizzuto, 2007).

Given these general premises, scientific research focusing on the protection and enhancement of territories rich in natural and cultural heritage is crucial. This research can address the dynamics that emerge with local communities and offer strategies to resolve identified critical issues.

In contrast to other parts of the world, where conflicts may arise from the desire of different local communities to "manage" natural resources, in Sicily's interior regions, the conflict exists between cohesive local communities and authorities seeking to establish a park, aiming to protect natural and cultural resources.

The socio-political context in which authorities operate is a crucial factor within conservation debates (Bontempi et al., 2023). This study is part of broader scientific research on protected areas in Italy, with a specific focus on Sicily (Ronsivalle, 2018; Bazan et al., 2019), and locally addresses comprehensive sustainable development policies. In light of natural resource protection and conservation efforts, the recent proposal to establish a natural park under current Sicilian regulations – which differ somewhat from national standards – has presented challenges, particularly due to opposition from local communities whose territories are fully or partially within the proposed park boundaries.

A key issue is the difficulty stakeholders face in accepting the constraints and high levels of protection imposed by the natural park and in recognizing the potential benefits for local development and the ecological economy (Angelini & Pizzuto, 2007; De Rossi, 2019; Carta et al., 2024).

Therefore, the first step in this research is to understand the evolution of two main topics over the past five decades: natural and cultural heritage protection, and the role of landscape in spatial planning. The second step involves the collaborative efforts between the Sicani Park Authority and the Department of Architecture at the University of Palermo to develop comprehensive solutions for balancing transformation and conservation.

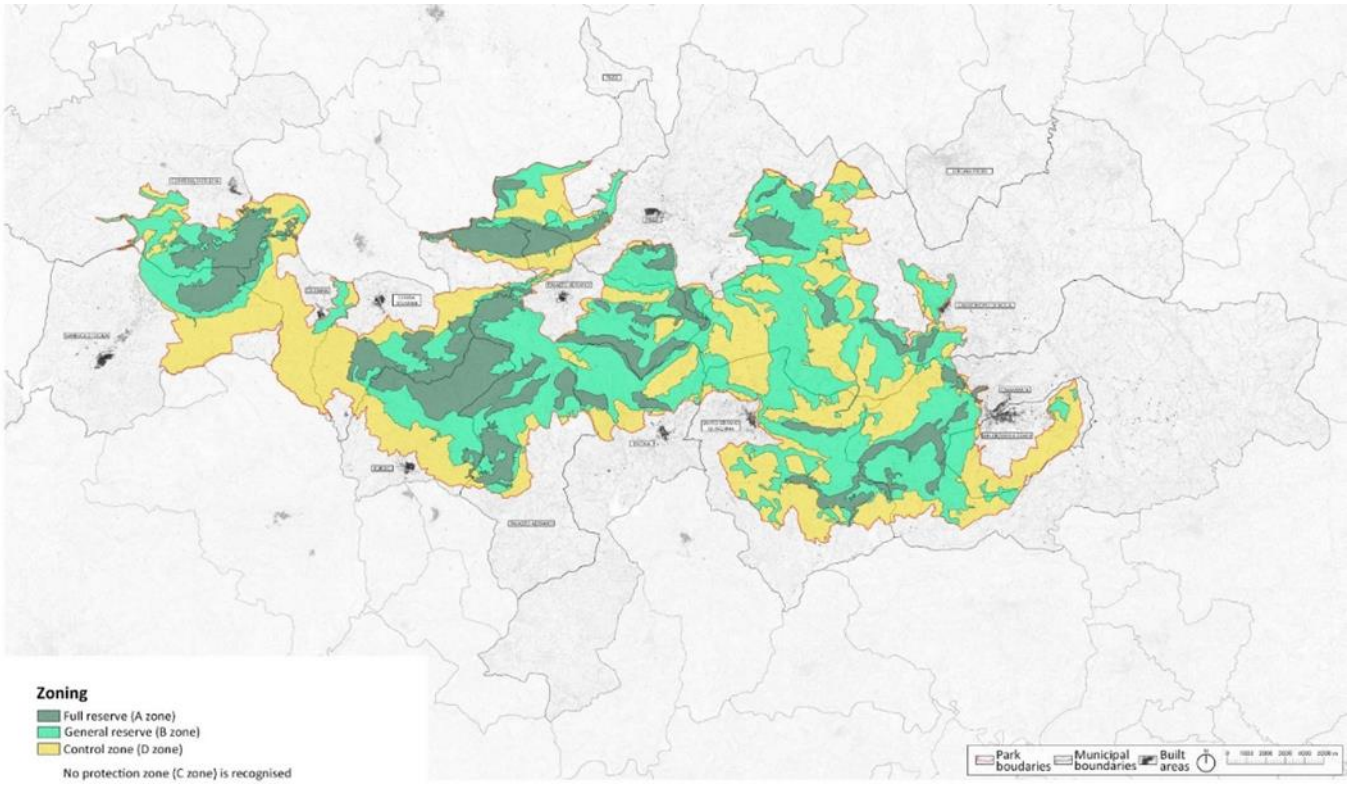
The study aims to establish a new institutional framework for the development of sustainable communities with more inclusive and shared public spaces (Lara-Hernandez, Melis, & Lehmann, 2019), promoting a shift in perspective on the protection of nature and landscapes – from being seen as a burden to being recognized as an opportunity.

Patrick Geddes's concept of "ecosophy" (1915) remains relevant today, emphasizing the importance of integrating natural and cultural heritage protection into local development strategies. This approach underscores that protection and transformation need not be in opposition when it comes to the socioeconomic growth of local territories and communities. Only a comprehensive, contextualized, and non-sectoral territorial evaluation of cultural heritage and landscapes can support the prioritization of protection efforts and the identification of opportunities for the coherent reuse of cultural heritage (Carta, 1999).

In recent years, two key aspects have gained prominence: landscape quality as a

globally recognized goal in territorial transformation, and the sustainable use of soil resources (near-zero soil consumption) as a priority for preserving natural heritage and ensuring hydrogeological balance. These theoretical components are central to the development of protected areas, and in this context, the University of Palermo and the Sicani Regional Park Authority have collaborated to address the challenges specific to Sicily's inner areas

Figure 1. Boundaries of the Regional Park of Sicani Mountains



Source: Elaboration by the Authors, on SITR database – Regione Siciliana

2. Theory

The research has focused on these issues with the aim of promoting more appropriate usage from a receptive, socio-cultural, and recreational perspective. Additionally, the research explores potential solutions for fostering economic development as a concrete opportunity for revitalization. This is approached through an integrated perspective that considers both the landscape and natural potential of the entire area, while also addressing new socio-economic dynamics to counteract regional crises, particularly the significant challenge of demographic decline.

Since 1975, the Amsterdam Declaration on the Protection of the European Architectural Heritage (Council of Europe) has highlighted the importance of fostering creative relationships between local communities and their natural and man-made cultural heritage. This perspective encourages viewing protection not solely as a conservative measure, but as a tool for local development and a strategic element for sustainability. The evolution towards a more complex human ecology – from ecology to ecosophy (Naess, 1988) – echoes Geddes's (1915) emphasis on understanding the full system of relationships within human settlements in their bioregions.

Over time, the approach to sustainable development has shifted from "ecological

fundamentalism" to a more nuanced understanding of development components. Raffestin (1995) advocates for a more equitable ecology, where the promotion of biodiversity is balanced with the encouragement of social and cultural diversity. This framework underpins the Sustainable Development Goals (SDGs), which support the integration of resilient and sustainable principles into practice (United Nations - Dept. of Economic and Social Affairs, 2015).

In recent decades, the governance of nature and landscapes has expanded, influencing public policies that go beyond mere protection. Decision-makers increasingly face conflicts, and resolving these tensions has become a priority in territorial governance. The evolution of territorial development objectives and planning tools over the past decades, both regionally and nationally (Carta, 1999), has necessitated transformative interventions on the cultural and landscape heritage, particularly in areas of high artistic and historical value.

However, contemporary natural heritage planning cannot be addressed as a sectoral issue alone. It must be treated as a relational problem between territories and communities, taking into account both the characteristic elements of territorial identity and the interactions between cultural heritage and other identity components. To achieve self-sustainable development, it is crucial to reconfigure the relationships between natural, socio-cultural, economic, and urban planning systems. It is evident that the "space without society" we live in (Sassen, 2013) is the product of a globalized approach, whose tragic consequences are seen in the depletion of natural resources, energy dependence, and the spread of new diseases, among other challenges. Planned territorial development has often been obstructed by conflicts between the extensive value of cultural heritage and the need for territorial transformation in line with new development models.

In conflict situations, responses have frequently been sectoral, alternating between prioritizing protection and development. In territories rich in artistic, historical, and natural value, integral conservation can often hinder effective planning and exacerbate conflicts. Therefore, a comprehensive and contextualized evaluation of cultural heritage and landscapes is essential. Such an evaluation can provide valuable indicators for prioritizing protection and identifying opportunities for the coherent reuse of cultural heritage.

This challenge is typical of planned human settlements, which often exclude unique and irreplaceable places from transformation processes, such as cultural and natural resources. Understanding how to resolve conflicts between expansion, transformation, and exclusion is critical for making the protection of cultural and natural heritage a shared interest that balances conservation and development.

Carta (1999) argues that a cultural framework based on the diversification of local cultures can provide scenarios that meet development needs while reducing conflicts between conservation and innovation. The community's recognition of the value of cultural and natural heritage in territorial growth processes can legitimize the exclusion of certain areas from transformation, which is necessary for territorial development. The tension between transformation and preservation can be resolved through a cognitive and interpretative framework that provides systemic knowledge of territorial structures, identifying invariant cultural, environmental, and landscape components as protected by law. Whatever development model is adopted, it cannot disregard the protection of the distinctive and invariant elements of the cultural framework. The cultural dimension of development is thus a critical issue for implementing environmental sustainability and nature conservation projects. It can contribute to the stability of the territorial system by fostering low-conflict behaviors based on solidarity and cooperation (Fabrizio, 1995).

In the IGBP newsletter, Crutzen and Stoermer (2000) coined the term "Anthropocene" to describe the significant impact of human actions on the planet, particularly in terms of territorial, structural, and climate changes. They could not have anticipated that, over the last two decades, pervasive "anthropo-development" would lead to irreversible human footprints on the planet. The identity structures of cultural and ecosystem palimpsests have been eroded, planetary metabolisms altered, and vital cycles, such as water and waste, disrupted. The depletion of natural resources continues at an accelerating pace, and the ability of urban settlements to maintain necessary connections with rural areas has been compromised.

The global polycrisis (Morin, 2020) has fuelled calls for degrowth, challenging humanity's capacity to develop integrated Man-Nature processes. During the same period, the European Landscape Convention (2000) was drafted by the Council of Europe. This document emphasizes democracy, human rights, and the rule of law, recognizing the landscape as essential for individual and social well-being and the consolidation of European identity. The Convention acknowledges the economic significance of landscapes and the need for clear guidelines to address the invasive changes affecting European landscapes. It defines landscape broadly, as an area shaped by natural and human factors, and calls for a participatory approach to landscape protection, management, and planning.

The 2017 Final Recommendation of the 9th Council of Europe Conference on the European Landscape Convention highlights the Convention's role in illustrating human rights, including health, well-being, and dignity, in relation to the landscape. This approach emphasizes the importance of incorporating landscape considerations into urban and regional planning through democratic and participatory processes.

The European Landscape Convention reframes landscape protection as a constitutional obligation, opening opportunities for transformation that align with landscape quality goals. This approach legitimizes protection through social, cultural, and economic considerations.

Parks and natural reserves play a crucial role in soil protection, that is described as "one of humanity's most precious assets"[1] (European Soil Charter, 1972). While the concept of "Sustainable Development" (World Commission on Environment and Development, 1987) and the Sustainable Development Goals[2] (UN, 2015) had not yet emerged at the time, it is now established that soil sealing poses significant risks to ecosystem services essential for life.

The alteration and loss of soil resources affect not only agriculture, rural landscapes, and the environment but also health (Munafò and Tombolini, 2014) and quality of life. Soil consumption results in the irreversible loss of organic carbon stocks, which are the product of centuries of natural and biological processes (O'Riordan et al., 2021). Sealed soil increases surface water runoff and erosion (Ferro and Bagarello, 2018) and disrupts biodiversity. Soil sealing also impacts the climate[3] by increasing energy consumption and emissions[4]. The loss of vegetation and increased solar absorption from asphalted surfaces contribute to the "heat island" effect.

The "artificial" areas identified by the CLC in Sicily (Table 1) account for 5% of the region's total area, a percentage comparable to the national average in Italy. However, it is crucial to halt soil consumption. This urgency arises not just from the extent of these artificial areas but from their distribution, which, as demonstrated in the case study, exerts a significant impact on the environment. The map illustrates the anthropogenic pressure on the ecological system, shown as a buffer around settlements and infrastructures, which frequently encroaches on protected ecosystems.

Table 1. Italian land use by Corine Land Cover Project (CLC, 2018) in Km^2

Regions	Artificial lands	Agricultural lands	Woods and seminatural lands	Wet lands	Inland waters	TOTAL
Piemonte	1.360,6	10.974,6	12.832,9	1,0	220,0	25.389,2
Valle d'Aosta	47,2	267,1	2.942,6	0,5	3,4	3.260,8
Lombardia	2.774,4	11.264,7	9.111,0	23,8	685,9	23.859,8
Trentino-Alto Adige	293,9	1.866,2	11.374,7	2,9	63,6	13.601,3
Veneto	1.702,0	10.364,6	5.319,2	227,1	810,6	18.423,6
Friuli-Venezia Giulia	623,0	3.001,5	4.054,8	26,5	154,0	7.859,8
Liguria	269,4	918,3	4.209,2	0,6	9,9	5.407,3
Emilia-Romagna	1.251,1	14.866,6	5.710,4	121,2	236,2	22.185,6
Toscana	1.119,2	10.454,9	11.253,6	55,9	103,1	22.986,7
Umbria	300,1	4.303,0	3.701,6	8,7	148,3	8.461,7
Marche	454,7	6.171,2	3.093,1	0,0	13,2	9.732,3
Lazio	1.099,0	9.706,4	6.156,8	7,4	258,1	17.227,8
Abruzzo	327,3	4.858,7	5.621,0	0,0	23,0	10.829,9
Molise	81,8	2.743,3	1.621,2	0,8	14,0	4.461,0
Campania	1.021,0	7.520,8	5.089,4	3,4	34,8	13.669,4
Puglia	1.067,1	15.760,0	2.452,9	91,2	167,2	19.538,3
Basilicata	158,8	5.737,5	4.130,1	9,3	37,0	10.072,7
Calabria	564,4	7.323,4	7.284,5	0,4	50,3	15.223,0
Sicilia	1.303,3	17.658,7	6.734,5	20,7	115,0	25.832,2
Sardegna	718,9	11.161,8	11.909,1	75,0	221,9	24.086,8
ITALY	**16.537,0**	**156.923,5**	**124.602,7**	**676,4**	**3.369,6**	**302.109,2**

Source: ISPRA, 2018

In urban and territorial planning, one of the critical effects to consider is hydrogeological risk, both in terms of safeguarding human life and minimizing damage from individual events. This concern is particularly pressing in light of ongoing climate change (Pörtner et al., 2022), which is leading to increased frequency of intense, short-duration rainfall events.

Over the past twenty centuries, the climate has remained relatively stable; however, in recent decades, significant and alarming changes have been observed (Acot, 2004). Droughts, heat waves, and extreme meteorological events such as hurricanes and torrential rains are all consequences of this epochal climate change. These changes result in environmental, social, and public health disasters. Global warming refers to the continuous rise in the Earth's average temperature, a trend that increases annually. According to the Intergovernmental Panel on Climate Change (Pörtner et al., 2022), this phenomenon is primarily driven by the greenhouse effect. Projections suggest that these changes could lead to a temperature increase of up to 6°C within a century.

The IPCC report indicates that global warming is very likely (with a 95% probability) caused by human activities (Table 2), particularly due to the emission of greenhouse gases (GHG). These emissions are largely attributed to carbon dioxide produced by the excessive use of fossil fuels for transportation, building cooling, industrial production, and especially soil consumption and deforestation[5].

Table 2. EU Greenhouse Gas Emission, 2019

Origin of emission	%
waste	3,32%
agriculture	10,55%
industrial processes	9,10%
energy	77,01%

Source: István, 2020

As shown in Table 3, the latest data from ISPRA (Munafò, 2022) provide a comprehensive overview of the current situation: in 2021, 2,148,515 hectares of land, equivalent to 7.13% of the total land area, had been consumed.

Table 3. Soil consumed in Italy

Region	2006 [%]	2012 [%]	2016 [%]	2018 [%]	2020 [%]	2021 [%]
Piemonte	6,33	6,54	6,58	6,6	6,65	6,68
Valle d'Aosta	2,08	2,10	2,13	2,1	2,14	2,15
Lombardia	11,54	11,88	11,97	12,0	12,08	12,12
Trentino-Alto Adige	2,92	2,97	3,02	3,0	3,05	3,06
Veneto	11,23	11,57	11,67	11,8	11,86	11,90
Friuli-Venezia Giulia	7,66	7,83	7,90	8,0	7,99	8,00
Liguria	7,10	7,18	7,22	7,2	7,24	7,25
Emilia-Romagna	8,44	8,68	8,78	8,8	8,87	8,90
Toscana	5,99	6,08	6,12	6,1	6,16	6,17
Umbria	4,96	5,14	5,21	5,2	5,26	5,27
Marche	6,54	6,79	6,85	6,9	6,93	6,94
Lazio	7,63	7,92	8,02	8,1	8,11	8,13
Abruzzo	4,70	4,85	4,90	4,9	4,98	5,02
Molise	3,75	3,83	3,86	3,9	3,91	3,92
Campania	9,97	10,20	10,33	10,4	10,45	10,49
Puglia	7,49	7,95	8,06	8,1	8,17	8,20
Basilicata	2,95	3,07	3,12	3,1	3,16	3,17
Calabria	4,76	4,94	5,02	5,0	5,05	5,06
Sicilia	6,13	6,33	6,42	6,5	6,50	6,52
Sardegna	3,17	3,23	3,27	3,3	3,31	3,32
ITALY	**6,75**	**6,95**	**7,03**	**7,07**	**7,11**	**7,13**

Source: ISPRA in Munafò 2022

In this paper, the urgency of establishing parks and natural reserves is emphasized, in line with current regulations. These protected areas are crucial for safeguarding soil resources from anthropogenic activities, as well as preserving plant species, landscapes, and biodiversity. According to data from the World Conservation Monitoring Centre[6] (UNEP), approximately 15% of the world's carbon reserves are stored within the global network of protected areas.

Italian Law No. 394 of 1991, which classifies protected natural areas, provides an official list and defines Regional and Interregional Natural Parks. The first article of the law outlines its objectives as follows:

- To contribute, in accordance with national interests and international conventions and agreements, to the safeguarding, management, conservation, and protection

of landscapes and the natural environment.
- To enhance the quality of life in terms of economic development and urban planning.
- To promote the leisure and cultural growth of citizens, the social and public use of assets, and to serve scientific purposes.

While Law No. 394 does not explicitly address "soil consumption," it does impose strict building restrictions, particularly in "A" zones (fully protected areas). In "B" zones (protected areas), only infrastructure that aligns with the park's protective mandate is permitted.

Globally, as highlighted in the Protected Planet database, over 21 million square kilometres have been designated as protected or conserved areas since 2010, with 42% of these areas being added in the last decade. This is promising news for both carbon sequestration and the reduction of soil consumption.

Protected and conserved area institutions also play a vital role in contributing to broader Sustainable Development Goals (SDGs), such as ensuring health and well-being, creating sustainable cities and communities, combating global climate change, and supporting life on Earth. These efforts align with SDG 12, which focuses on responsible consumption and production.

In inner areas, the landscape holds significant ethical value: natural and cultural heritage should be regarded as common goods (Nigrelli, 2019). This study aims to support the protection of inner Sicily. The unresolved community issues that hinder the formal establishment of the Sicani Mountains Natural Park threaten both the preservation of the ecosystem and the sustainable anthropogenic activities that respect soil resources.

3. The Role of University Research in Supporting Nature Protection in Sicily

The Department of Architecture (University of Palermo) and the Regional Park Authority of Sicani Mountains signed a research agreement in 2019 to "regulate the development in collaboration on activities of common interest," as stipulated in Article 15 of Italian Law No. 241/1990. This Agreement is not the beginning of a new collaboration but rather the culmination of joint research efforts that had already been initiated by the Park Authority and the Department. These efforts were supported by the institutional activities of the Park Authority and the public engagement and third mission activities of the local development research laboratory coordinated by Maurizio Carta at UNIPA.

The Regional Park Authority of Sicani Mountains has been engaged in activities to ensure the highest levels of environmental protection within the park, focusing on environmental protection, territorial enhancement, environmental impact assessment, soil conservation, and the preservation of natural heritage. For years, the Department of Architecture has conducted studies and research on local development in the Sicani mountains, particularly in the context of the National Strategy for Inner Areas (SNAI) and Local Action Group for Rural Development (GAL Sicani). These actions, aimed at knowledge, protection, development, and enhancement of the natural and cultural heritage of the Sicani region and its municipalities (Prestia and Scavone, 2015; Carta, Lino, and Orlando, 2018; Carta et al., 2024), reflect a deep interest in innovative approaches to local development.

The missions of both the Park Authority and the Department of Architecture have provided new sources of inspiration for identifying strategic areas to support the park's valorisation processes. The primary focuses of their joint research are:
- The presence of anthropogenic activities incompatible with nature protection,

according to both regional and national legislation.
- The compatibility of some functional zones outlined in municipal masterplans predating the park's establishment.
- The need to address community concerns regarding C and D zones, which are to be defined in the Park Regional Plan.

These three focuses relate to the contents of the Park Plan, as defined by Regional Law No. 98/1981. The Park Plan requires the Park Authority to designate four types of zones.

- Integral Reserve Area (A Zones): Areas where the natural environment is preserved in its entirety, including biological populations and their interdependence. These areas exhibit minimal anthropogenic activity and are of major naturalistic and landscape interest.
- General Reserve Area (B Zones): Areas where new construction, expansion of existing buildings, and land transformation are prohibited. However, agroforestry, pastoral uses, and essential infrastructure such as access roads and improvements may be permitted. These areas have a lower degree of anthropization compared to A Zones.
- Protection Area (C Zones): Areas where building transformation and land conversion are allowed if they enhance the park's key purposes, such as cultural tourism and tourist accommodation.
- Control Areas (D Zones): Areas where anthropogenic activities are permitted only if compatible with the park's objectives.

The C and D Zones were excluded from the Plan, and their planning requires co-design with local municipalities. No solutions have been approved yet due to conflicts between the Regional Authority, protection activists, and various stakeholders concerned about potential restrictions on their businesses.

In this context, the Park Authority decided to shift perspectives and focus on research to resolve local conflicts through a detailed assessment of critical issues. The main criticalities are summarized as follows:

- Areas planned in local masterplans approved before the park's establishment, which allow high-level transformations conflicting with nature protection. These areas remain in an uncertain state.
- Areas currently used for incompatible activities, such as stone quarries.
- The Municipality of Lercara Friddi's request to include an area of natural interest in the Park, which could alter its status and create new opportunities for the park.

4. Methodological approach and contents

To tackle the challenge of redesigning the C and D zones, the research group employed an overlay mapping approach (McHarg, 1969; Steiner, 2004). This approach is rooted in a structural planning method that considers the interrelation between natural and anthropogenic factors (Carta, 2009; Carta et al, 2017).

Overlay mapping involves superimposing multiple data sets, each representing different themes, to identify relationships and assess the cumulative effects of specific anthropogenic actions. By overlaying these data sets, the technique allows for the creation of composite maps that integrate the geometry and attributes of the individual data sets. This method facilitates a comprehensive understanding of how various factors interact and impact the landscape, supporting more informed decision-making in the planning process.

The method was applied to QGIS A Coruña environment[7], starting with an expedited overlay of official datasets and documents:

- perimeter of the Park and its zoning according to D.A. n.281/2014, corresponding to the last perimeter in force before the cancellation of the Decree establishing the Park (Figure 1);
- data sets available from the WMS services of the Regional Territorial Information System (SITR) and the Italian Institute for Environmental Protection and Research (ISPRA), in particular:
  1. the regional cartography at scale 1:10,000 (CTR);
  2. the national Carta della Natura Information System;
  3. the CORINE Land Cover 2012 and 2018 (third level);
  4. the current proposal of the Sicilian Ecological Network;
  5. the analytical maps of the Landscape Plans of the provinces of Palermo and Agrigento, even if not approved or being approved;
- map and documentation of the Regional Plan of Quarries and Mines;
- map and documentation of the Sicani Territorial Management Plan for the Natura 2000 Network;
- maps and documentation of local masterplans from the Municipalities (unavailable on SITR);
- on-field inspections and check on up-to-date satellite (Google Earth Landsat/Copernicus) and regional orthophotography (2000);
- socio-demographic data set from National Statistics Institute (ISTAT).

The maps released by the research group and shared with Park Authority are divided into three sections: a) current status; b) rights status; c) proposals, as below described.

Furthermore, the group worked in order to solve some boundary conditions caused by the scale and basic cartography adopted for the initial perimeter (IGM 1:25,000) against the more exact and widely used regional cartography (CTR ATA 1:10,000).

Table 4. Demographic dynamics of the municipalities

Municipality	Prov.	1971	1991	2011	2020
Castronovo di Sicilia	PA	3.895	3.604	3.175	2.944
Chiusa Sclafani	PA	4.125	3.677	2.957	2.682
Contessa Entellina	PA	2.207	2.052	1.865	1.608
Giuliana	PA	2.619	2.478	2.032	1.802
Lercara Friddi*	PA	9.536	7.602	6.935	6.626
Palazzo Adriano	PA	3.081	2.767	2.227	1.928
Prizzi	PA	8.057	6.254	5.055	4.508
Bivona	AG	5.043	5.076	3.882	3.438
Burgio	AG	3.731	3.562	2.780	2.586
Cammarata	AG	6.950	6.332	6.275	6.048
Sambuca di Sicilia	AG	7.229	6.797	6.114	5.680
San Giovanni Gemini	AG	7.777	8.420	8.127	7.816
Santo Stefano Quisquina	AG	5.902	5.628	4.897	4.337
		70.152	**64.249**	**56.321**	**52.003**

Source: elaboration by the authors based on ISTAT census (www.istat.it)

5. Results

The research results consist of a set of maps and reports designed to support decision-making in a joint conservation and development-centred approach. The outputs include status analysis maps that describe the Park from ten different perspectives, as well as detailed dossiers that elaborate on the design approach. As mentioned in

the introduction, the research addressed two primary challenges: the quarrying area critical conditions and the consistency of planning forecasts. Additionally, a third focus was the request from the Municipality of Lercara Friddi to join the Park, which involves incorporating new naturalistic areas of significance to habitat quality.

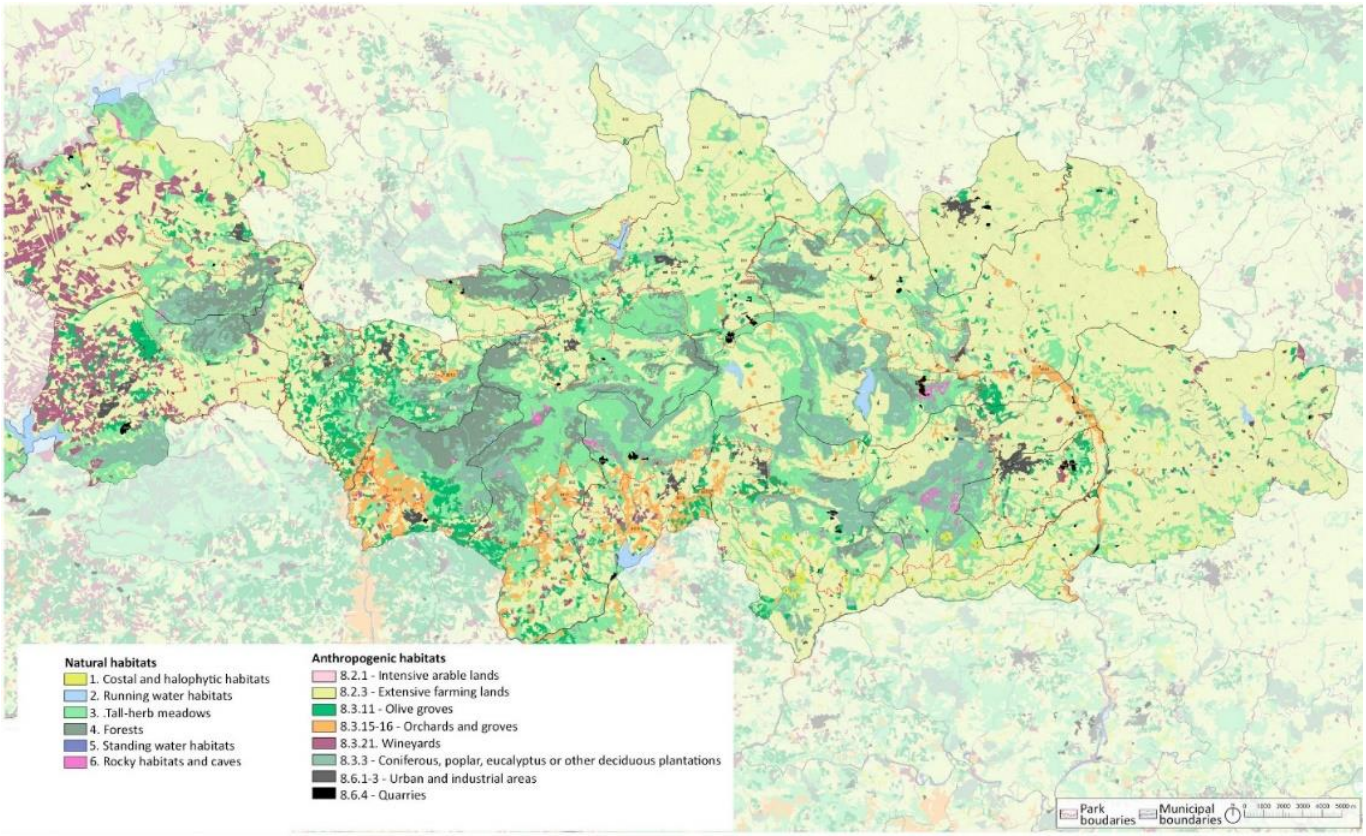
5.1. The status analysis

To tackle the challenge of redesigning the C and D zones, the research group adopted the overlay mapping approach (McHarg, 1969; Steiner, 2004), integrating a structural approach to planning where natural and anthropogenic factors are closely interrelated (Carta, 2009; Carta, Lino, and Ronsivalle, 2017). The status analysis comprises seven maps:

- Map No. 1 (Figure 1) illustrates the area of the Natural Park and the twelve municipalities partially within its boundaries. This map also highlights the municipality of Lercara Friddi, which, although currently outside the Park, has formally requested to join following an assessment of its natural and landscape conditions. The map identifies the park's boundaries and zoning according to Decree No. 281/2014. While the integral reserve (Zone A), general reserve (Zone B), and control zones (Zone D) are legally established, the protection zones (Zone C) remain to be officially defined.
- Maps No. 2/A and No. 2/B depict the orography, hydrography, and infrastructural network of this part of Sicily at different scales. These maps show road classifications by competence and dimension. The region features varied orography, predominantly hilly with mountain stretches reaching up to 1600 meters above sea level, with notable contributions from the Fanaco, Gammauta, Prizzi, and Pian del Leone lakes.
- Maps No. 3 and No. 4 analyse land use and land cover based on the regional "Carta della Natura" (Figure 2) and Corine Land Cover (2018, third level). These maps provide a snapshot of the territory, revealing extensive arable cultivation and vineyards in the western part, and significant natural areas with woods and forests in the central region.
- Map No. 5 details cultural resources and identifies various anthropogenic components of the Sicani area's cultural heritage. This map, updated with data from the Landscape Plans of the provinces of Palermo and Agrigento and the Natura 2000 Management Plan, includes:
  - Archaeological Heritage: sites and areas of archaeological interest.
  - Fortification Heritage: castles, towers, and other military structures.
  - Ecclesiastical Cultural Heritage: monastic architecture, places of worship, and cemeteries.
  - Residential Heritage: historic centres and ancient residential buildings.
  - Cultural Heritage for Productive Purposes: agricultural architecture, water management structures, and mining/quarrying sites.
  - Cultural Heritage of Facilities and Equipment: infrastructure serving roads and social, accommodation, and leisure services.

The anthropized landscape is notably characterized by cultural heritage related to productive purposes, reflecting the historical agricultural focus of the Sicani Mountains region.

Figure 2. Map of the habitat in the Park of Sicani Mountains



Source: Elaboration by the Authors, on SITR database – Regione Siciliana

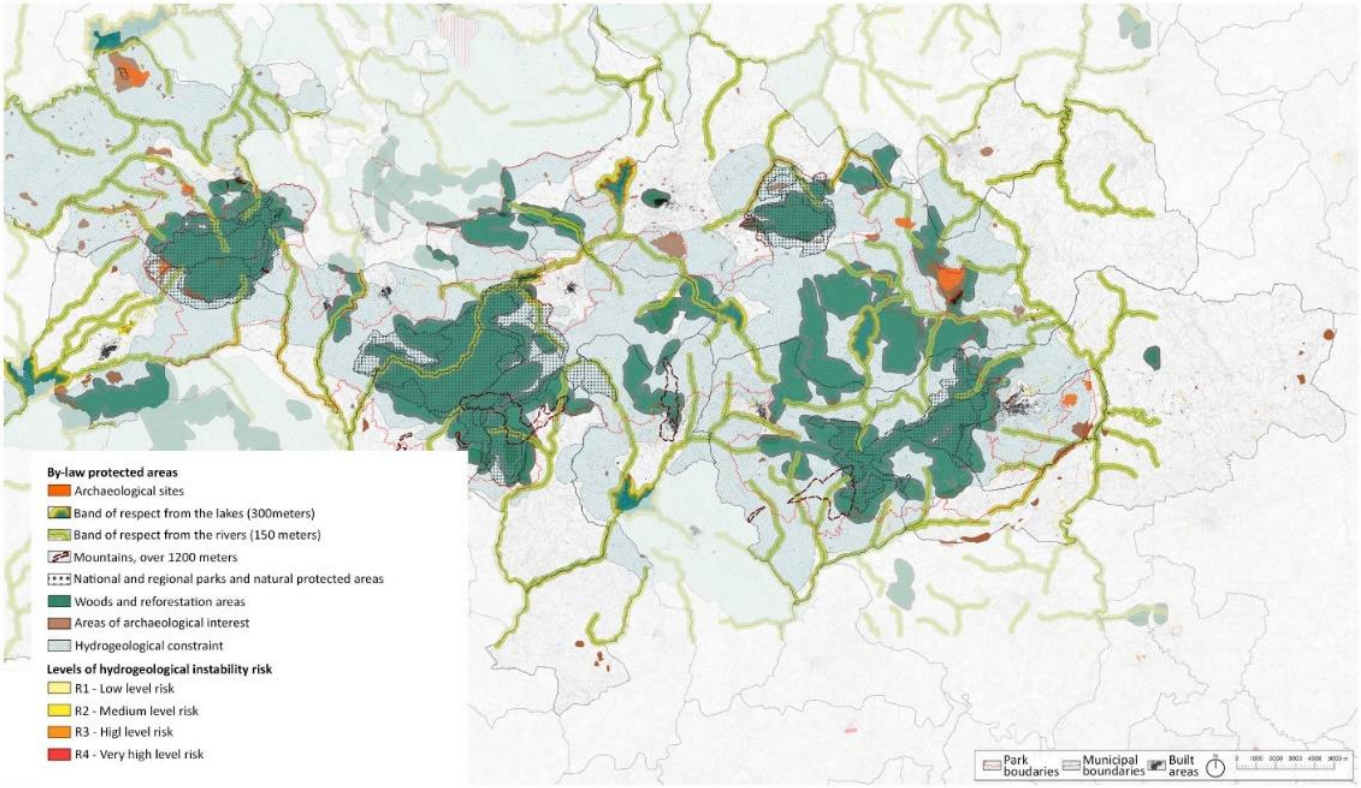
Finally, another map examines anthropogenic pressure based on the Management Plan for Natura 2000 sites in the Sicani Area, as compliant with Decree No. 667/2009, detailed in the report attached to the same plan (pp. 64-162). This map highlights significant anthropogenic pressure in the western part of the park, which could jeopardize the ecological and environmental stability of the region.

- Map No. 7 (Figure 3) depicts the legal regime affecting the Park and its municipalities. It overlays landscape constraints, hydrogeological constraints, and the risk of hydrogeological instability as identified by the Hydrogeological Preservation Plan (PAI). Notably, the map shows the presence of hydrogeological and forest constraints in the integral reserve (Zone A) and general reserve (Zone B) areas of the park.

The rights analysis consists of three maps that illustrate plans and regulations established by various stakeholders:

- Map No. 8 shows the Natura 2000 Network, identifying the Special Conservation Zones (SCZs) and Special Protection Zones (SPZs). These zones cover nearly the entire Park and extend into its northern part, including the Rocca Busambra near Corleone. It also highlights significant habitats such as “Forests of Quercus ilex and Quercus rotundifolia” (Code 9340) and “Calcicolous formations of xerophytic sands” (Code 5332).
- Map No. 9 reproduces the “Map of Actions and Management Strategies” from the Natura 2000 Management Plan for the Sicani Area. This map outlines the actions to be taken within the SCZs for environmental protection and socio-economic revitalization, relevant to the Municipality of Lercara Friddi’s request.
- Map No. 10 presents a draft of the Sicilian Regional Ecological Network as proposed by the Department of Territory and Environment of the Sicilian Region.

Figure 3. Areas protected by law in Sicani area



Source: Elaboration by the Authors, on SITR database – Regione Siciliana

5.2 Proposal dossiers

As a working method, the research group adopted the solution of drafting three dossiers that respond to the three main topics (conflicting anthropogenic activities, incoherent municipal zoning, request of accommodation and service areas), ready for the next step of co-planning at both institutional and community level.

Dossier A: Quarry Management within the Park

The document provides an overview of both active and disused quarries within the Park. Quarrying activities are generally prohibited in regional natural parks according to Article 17 of Regional Law No. 98/1981 (later replaced by article 16 of Regional Law No. 14/1988), making their presence within the park a significant issue. This dossier identifies nine quarries –decommissioned and currently operational under concession – in the municipalities of Bivona, Castronovo di Sicilia, Palazzo Adriano, San Giovanni Gemini, and Santo Stefano Quisquina.

The analysis includes:

- Classification of the quarries using orthophotography and the Regional Topographic Map (CTR).
- Evaluation of their compatibility with the Park's zoning regulations.
- Identification of transportation routes used for moving quarry materials out of the Park.
- Documentation of valuable anthropogenic cultural elements in the vicinity, potentially utilizing extracted materials.

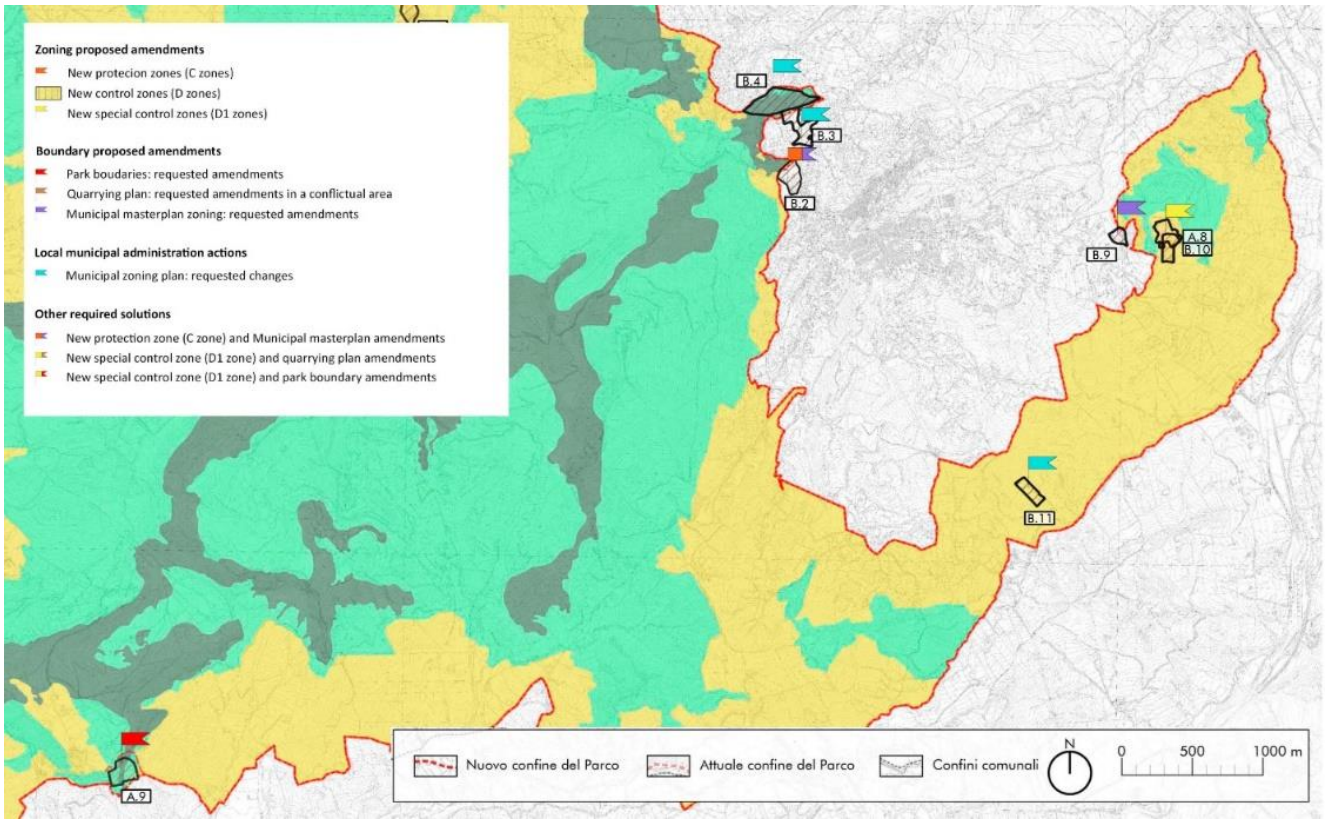
Rather than viewing quarries as adversaries, this study aims to explore their potential as part of the park's identity and to propose actions that align with conservation goals. Recommendations include:

- For quarries on the Park's edge either remove the quarry from the Park's

perimeter or allow operations to continue until exhaustion, depending on the area's current condition.

- For quarries entirely within the Park establish a new area, "D1", where the quarry site can be repurposed for activities such as sports, recreation, and education. Alternatively, the site could be restored to contribute to environmental protection. It is also recommended to clearly define infrastructure networks to integrate them into the control zone (D).

Figure 4. Map extract from Dossier A and Dossier B



Source: Elaboration by the Authors, on SITR database – Regione Siciliana

Dossier B: Analysis of Zoning Non-Compliance

This dossier addresses discrepancies between municipal General Regulatory Plans and the Park regulations. Eighteen non-compliant areas across various municipalities have been identified: Bivona (one area), Cammarata (three areas), Chiusa Sclafani (one area), Giuliana (one area), Sambuca di Sicilia (two areas), San Giovanni Gemini (three areas), and Santo Stefano Quisquina (seven areas). Most non-compliance issues stem from a "temporal" mismatch, with the planning forecasts predating the Park's establishment. The analysis involved:

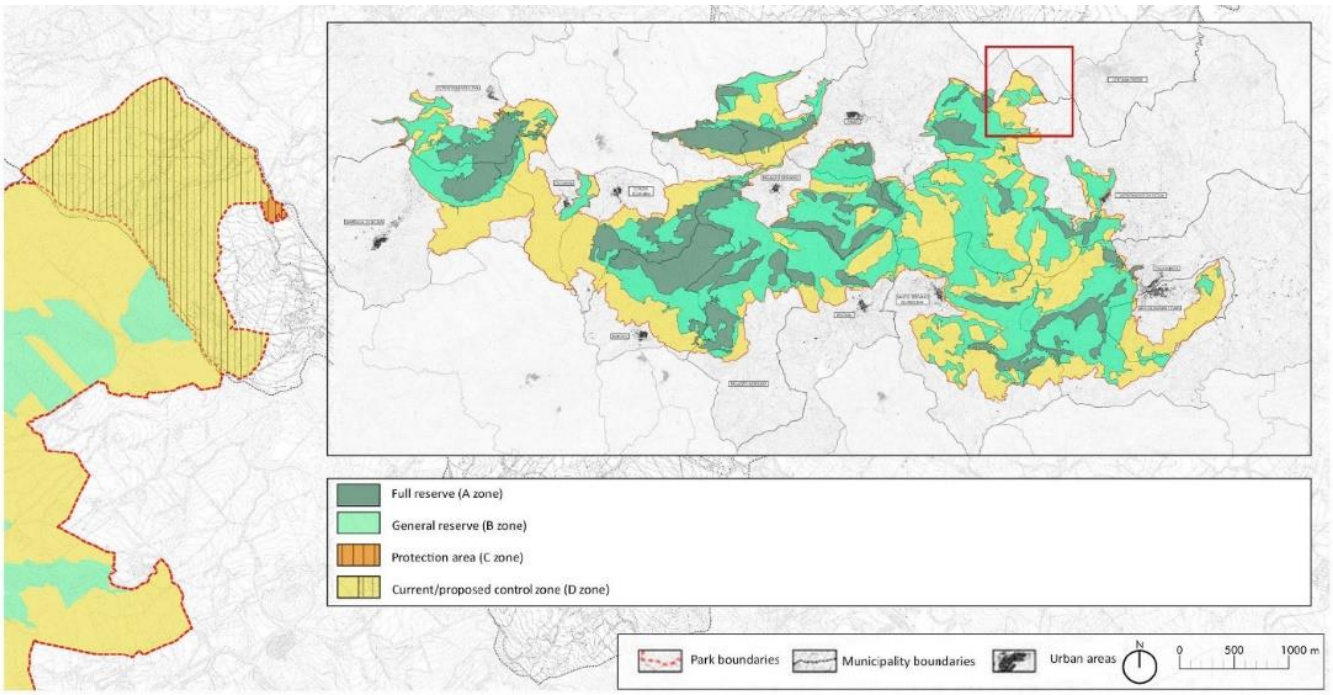
- *Mapping*: Framing the affected areas using orthophotos and the Regional Topographic Map (CTR).
- *Contextualization*: Relating these areas to the Park's zoning.
- *Assessment*: Evaluating the level of urban transformation and soil sealing within and around these areas.

In some cases, non-compliance results from cartographic errors. For these, it is proposed to adjust the Park's boundaries administratively to exclude the quarry areas. For other areas, where the planned use is for tourism or urban facilities, it is recommended to rezone them as protection zones (zone C) or facilities zones (zone F), which align with the Park's objectives. Areas within the integral (zone A) or

general (zone B) reserves should be excluded from these zones. In a specific case where zoning overlaps with a quarry near the historic centre of San Giovanni Gemini, the proposal is to designate the area as "D1" for special use.

Dossier C: Integration of Lercara Friddi into the Park
The document focuses on the proposal to include an area of high environmental value within the Municipality of Lercara Friddi into the Park. This follows Lercara Friddi's formal request to join the Park's community. The analysis supports the inclusion of a Special Area of Conservation, previously identified in the Strategic Actions of the Management Plan for the Sicani Territorial Area. The proposed integration aligns with the Park's conservation goals and has been favourably assessed.

Figure 5. New boundary proposal to admit Lercara Friddi



Source Elaboration by the Authors, on SITR database – Regione Siciliana

Regarding land cover status, we identified areas characterized by extensive arable land and both broadleaved and coniferous woods. Specifically, zone E1 (agricultural areas) as defined by the General Regulatory Plans of Lercara Friddi aligns well with the goals of the Regional Park. Consequently, we propose designating this area as a control zone (zone D) in conjunction with a protection zone (zone C). This zoning would allow for public parking to support leisure activities at the northeast entrance to the Park. The proposed changes to the zoning and the types of interventions required are illustrated in Figure 5.

6. Discussion and conclusion

The study addresses a critical conflict within an inner area of Sicily, where environmental-territorial disputes are increasingly prominent in public discourse (Staniscia, 2022). Providing comprehensive cognitive tools at appropriate scales is essential to facilitate communication and understanding among local communities and external stakeholders. The spatial analysis of the Regional Natural Park of the

Sicani Mountains focused on identifying strategies and actions to resolve conflicts that have hindered the Park Authority's activities, leading to its temporary dissolution and the need for new institutional frameworks and community consultations.

The knowledge framework produced has been officially adopted by the Sicilian Region and the Park Authority as an enhancement to existing regional protected area databases. The revitalization of the Sicani inner territory, which has experienced a 25% population decline and a nearly doubled elderly population over the last 50 years, hinges on leveraging the Park's resources. Unlike coastal urban systems, inner areas face abandonment, socio-productive fragmentation, and exclusion from development processes. Traditional economic activities are not evolving with new economic forms but are rather being undermined.

Quarrying, a central conflict in this study, exemplifies how the territory is eroded rather than enriched, leading to a loss of valuable resources and hindering local development. The study provides a comprehensive overview aimed at addressing territorial and social regeneration, enhancing the natural heritage, and utilizing local resources to counter economic and demographic challenges.

The Park Authority found the detailed approach in the "Dossier" documents valuable, addressing various issues and proposing suitable local solutions that balance protection and development. The research tackled several main challenges in preparation for institutional and community co-planning:

- Addressing anthropogenic activities incompatible with nature protection, with specific solutions provided in Dossier 1.
- Redrawing functional zones from municipal masterplans that conflict with Park regulations, proposed for inclusion in the Park Plan.
- Proposing new zoning for C and D zones, incorporating reused anthropized areas like former quarries.

To address the redesign of C and D zones, the research employed overlay mapping (McHarg, 1969; Steiner, 2004), incorporating a structural approach to planning where natural and anthropogenic factors are interrelated (Carta, 2009; Carta, Lino and Ronsivalle, 2017). The Preamble to the European Landscape Convention (Council of Europe, 2000) advocates for sustainable development through a balanced relationship between social needs, economic activity, and the environment. Protection should combine ecological and environmental considerations with landscape design to achieve a sustainable future.

This research offers a comprehensive approach to analysing and assessing natural and semi-natural areas in parks and their interaction with human activities. The maps and dossiers advance GIS-based analysis, evaluating boundary conditions qualitatively to support community development and nature protection. Moreover, the results propose solutions for implementation. Thirty years after the national law on protected environments (1991) and forty years after regional laws on parks and reserves (1981), parks in Italy can play a crucial role in natural protection, territorial quality, and supporting local economies. They can counter hydrogeological disruption and depopulation, fostering territorial cohesion through community involvement. The renewed attention to environmental and landscape issues by citizens, associations, and institutions (Fregolent and Savino, 2014) underscores the need for institutional actors to seize project opportunities for protection. Parks can evolve into laboratories for new productive, environmental, and social relationships between urban and natural areas, fostering self-sustainable local development models.

Notes

1. European Soil Charter, RES (79)19E, point 1.
2. https://sdgs.un.org/goals.
3. https://www.isprambiente.gov.it/it/progetti/cartella-progetti-in-corso/suolo-e-territorio-1/iffi-inventario-dei-fenomeni frano si-in-italia.
4. In the viewer: www.eea.europa.eu/data-and-maps it's possible to find data on greenhouse gas emissions and removals.
5. https://www.unep-wcmc.org/en.
6. https://www.protectedplanet.net/en/thematic-areas/wdpa?tab=WDPA.
7. https://www.qgis.org/en/site/forusers/download.html.

Author Contributions

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Conflicts of Interest

The authors declare no conflict of interest.

Originality

The authors declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere, in English or any other language. The manuscript has been read and approved by all named authors and there are no other persons who satisfied the criteria for authorship but are not listed. The authors also declare to have obtained the permission to reproduce in this manuscript any text, illustrations, charts, tables, photographs, or other material from previously published sources (journals, books, websites, etc).

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