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Indicators-based spatial SWOT analysis: Supporting the strategic planning and management of complex territorial systems

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ABSTRACT

Optimizing the multiple uses of land represents a challenge for today's governments and land managers. In particular, protected area planning should satisfy the demand for multiple land uses, while offering optimal protection of our natural resources. The present research aims at providing park's managers, as well as other stakeholders and decision makers, with a scientifically sound and practical approach to zoning protection levels and supporting the strategic planning phase in nature conservation. This paper thus proposes and tests the development of an indicators-based spatial Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis for a complex territorial system with exceptional multiple values. As a result, key conservation priorities and warning spots are identified to support the subsequent decision-making phase. The innovative value of the research stems not only from the integrated methodological approach based on the combination between spatial analysis, indicators systems and the traditional SWOT analysis, but also from the contextual characteristics and physical extension of the area under investigation. Moreover, the integrated and innovative framework proposed in the paper has also international significance, thanks to the possibility of replicating the research strategy and methodological approach in other contexts.

1. Introduction

Protected areas and parks serve many functions: protection and maintenance of biological diversity (IUCN, 2010), implementation of environmental aspects, conservation of cultural, architectonic and historical values. These functions are rarely enclosed in the same area, however, when this happens, management and planning requires great efforts.

International efforts to preserve the natural environment are mainly concerned either with large biodiversity or with individual animal or vegetal species, endangered or threatened with extinction. Less scientific and political attention is being paid to that areas close to where people live and to small-scale protected areas (Chiesura, 2004).

The recent cuts in the budget to preserve the environment reflect the difficulty to implement management plans for protected areas close to the urban structure, which actually provide important ecosystem services for urban areas. Taking into account the enormous development of townscapes foreseen for the future, the management of these parks is expected to play an increasingly important role in the future.

As a matter of fact, the proper management of a protected area or natural park provides many benefits (Solecki and Welch, 1995) and the intensity of these benefits is directly proportional to the economic value attributed to the natural area and to its ability to provide ecosystem services (De Groot et al., 2002; Fisher et al., 2009).

Production, hunting, fishing and recreational use usually bring disturbances such as direct reduction of species populations, habitat degradation and fragmentation. These disturbances in turn may influence ecosystem composition and processes of change in behavioral patterns of species (Geneletti and Van Duren, 2008). Proper management plans should thus satisfy the demand for multiple land uses, while offering optimal protection of our natural resources.

In order to increase the value of a protected area it's important to have a deep knowledge of the same and of the surroundings. Nowadays, advanced technologies and database exist and the public authorities are responsible for providing reports and accounts of statistics on protected areas including historical, architectural, environmental and natural information (EEA, 2009a,b,c; Marcer et al., 2010). Unfortunately, most of these data are focused on particular topics and do not take comprehensively into account the

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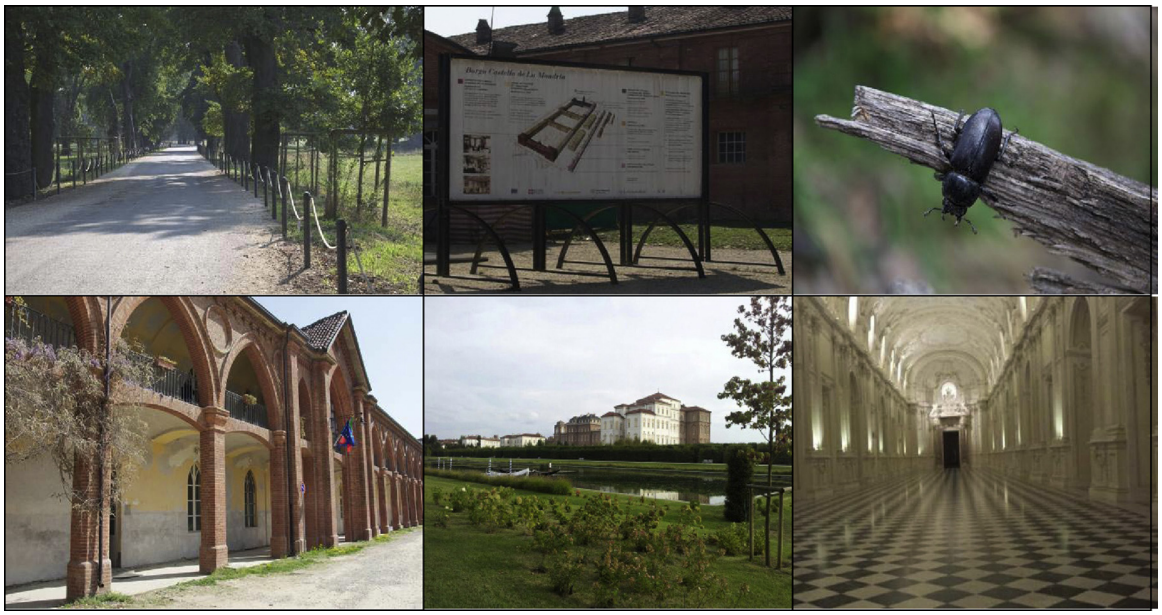

Fig. 1. A snapshot of the key elements determining the exceptional value of the natural Park "La Mandria". From the top left to the right: the "*Quercus robur*" rows, the protected compound "Borgo Castello", the *Osmoderma eremite* protected beetles; a particular of the protected building "Borgo Castello", the view of the Venaria Royal Palace, and the Big Juvarra's Gallery inside the Venaria Royal Palace.
Source of the photos: authors' property.

whole protected area system with all the factors involved (Marcer et al., 2010; Phua and Minowa, 2005). Moreover, these factors are rarely spatially located. At the same time, digital archives database and information systems are not user friendly.

Park planners and managers consequently face the problem of selecting the most appropriate evaluation framework and indicators.

Because of their nature, environmental goods (such as protected areas, urban parks, forests, etc.) thus call for systemic approaches.

The interest in sustainability assessments based on indicators has been highlighted in different fields (e.g. Pasqualini et al., 2011; Horizon 2020; Ferretti and Pomarico, 2013) and the need for proper methodological approaches has been recognized.

The purpose of this paper is to provide an integrated framework of analysis, evaluation and definition of future actions according to a comprehensive set of indicators, some of which to be maximized and some others to be minimized, in order to help and support planners, policy and decision- makers, local authorities and public organizations to manage complex territorial systems characterized by multiple values. To schedule a proper management plan within a protected area, planners need to know: what is there and where it is.

The original contribution of this paper lies in combining environmental tools with spatial information. The research result is a simple and easy to manage and to explain instrument, useful to increase the value of each function of the protected area.

The paper, through a real-life case, combines Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis and Geographic Information Systems (GIS). The output consists of thematic maps of the different indicators considered in the SWOT analysis, as well as in overall maps for each area of concern. Furthermore, the obtained maps should be considered as dynamic representation of opportunities and threats to be updated according to the monitoring of territorial systems' change.

The proposed methodological approach enables decision and policy makers to evaluate the relative priorities of management based on a set of spatial factors. By ensuring an high degree of transparency, that is a crucial aspect for addressing public policies toward sound decisions, the proposed approach can be of international relevance for other parks worldwide where there is a need to establish or update their zoning scheme and where multiple values have to be taken into account at the same time.

The reminder of the paper is organized as follows: Section 2 illustrates the characteristics of the area under investigation; Section 3 presents the methodological background for the development of a spatial SWOT analysis; Section 4 proposes the application of the innovative spatial SWOT approach based on ecological and environmental indicators to the "La Mandria" natural Park; Section 5 discusses the obtained results and, finally, Section 6 presents the conclusions that can be drawn from this research.

2. The complex and exceptional value of the context under analysis

The case study proposed in this paper is based on a consultancy and research project on which the authors of the paper worked between 2013 and 2014, in close collaboration with the "La Mandria" Park management unit. In particular, the demand expressed from the Park management unit refers to the need to support the strategic planning of the Park zoning and management.

The natural Park "La Mandria", established as a regional protected area since 1978, is surrounded by 30 km of walls, which makes it one of the biggest fenced-in parks in Europe. The protected area covers about 6570 ha (1780 of which are property of the Region) and is controlled by the Authority for the management of protected areas within Turin's metropolitan region. According to the Regional Law 54/1978, the Park is divided in two areas: (i) the core park (3124 ha) aiming to protect the naturalistic and cultural value of the area and (ii) the buffer park (3446 ha) aiming at gradually connecting the core park with the surrounding areas, equipped with services and infrastructures.

The Park has an exceptional historical and architectural heritage (Fig. 1) including more than 20 protected buildings, among which

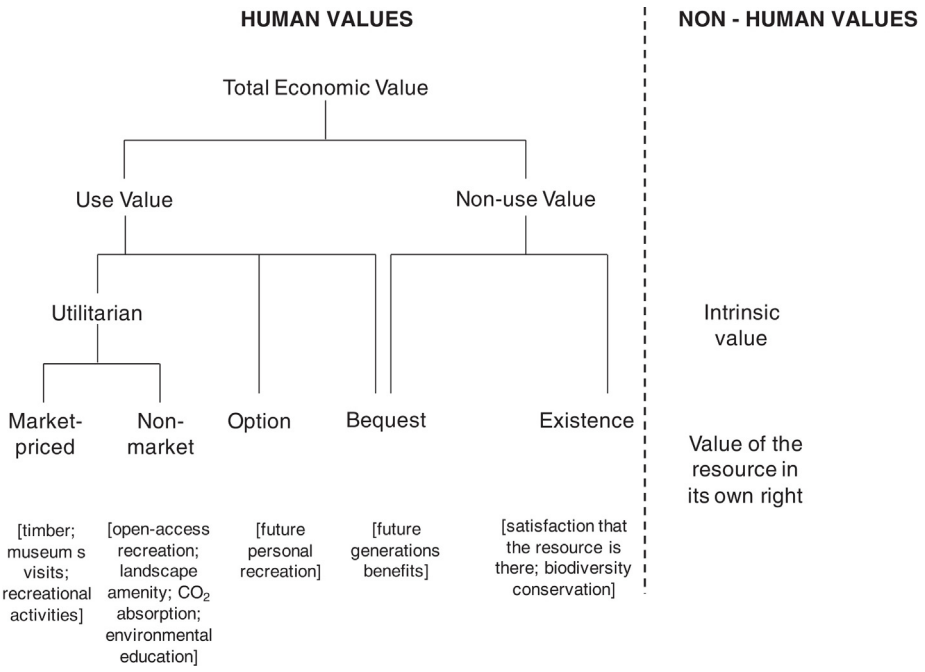

Fig. 2. The Total Economic Value for the natural Park "La Mandria".
Source: elaboration from Bateman et al. (2003).

Table 1
The SWOT matrix.

	Helpful to achieving the objective	Harmful to achieving the objective
Internal (attributes of the project)	Strengths: endogenous factors that describe the socio-cultural, physical and functional characteristics of the system. These characteristics are the resources with which the system is equipped and that is able to use in order to achieve its objectives.	Weaknesses: endogenous factors that describe the deficiencies of the system and the obstacles to the development processes. These characteristics refer to the internal limits of the system which make the achievement of the objectives more difficult.
External (attributes of the environment)	Opportunities: circumstances that are exogenous to the system and that can be enhanced by proper politics in order to increase the strengths or reduce the negative effects of the weaknesses. The opportunities are situations belonging to the external context that are favorable to the system and that can activate or support development processes.	Threats: circumstances that are exogenous to the system, as for instance socio-cultural trends of the local system, which could weaken the strengths of the system, exacerbate the weaknesses, prevent the system from catching the opportunities and increase the risk of the development processes. The threats are situations belonging to the external context that are unfavorable to the system and that can frustrate its short-term, medium or long-term strategy.

Table 2
The SWOT Analysis.

	Strengths (S)	**+Opportunities (O)**
+	- The farms' system - The Lakes and the "Lake Villa" - The Museum of the Royal Apartments ("Borgo Castello") - Recreational/sports activities - Areas with high naturalistic value - Presence of the "*Osmoderma eremite*" (Carpaneto et al., 2010; Ranius and Nilsson, 1997; Ranius et al., 2005).	- Proximity to the "Venaria royal palace" - Golf club - Public Transport Stops - Accessibility
	Weaknesses (W)	**–Threats (T)**
–	- Farms to be repaired - Unsafe *Quercus robur* - Anthropic pressure areas - Cultivated land - Private areas inside the park - Wetlands	- "Ceronda" stream - "Stura di Lanzo" river - Parking areas - "Magneti Marelli" industry - Hydrological risk
	Internal	**External**

the "Borgo Castello", many farms, some medieval ruins and two rest areas for hunting. Moreover, the Park is a UNESCO site since 1977 within the system of Piedmont Royal Residences. In particular, two of these residences can be found inside the Park area: the Venaria Royal Palace and the Castle with the royal apartments.

Being also a Site of Community Importance (SCI), the natural Park "La Mandria" represents a strategic area, from both the point of view of the Natura 2000 network and the Sabaudian royal residences' system. In particular, with reference to the Natura 2000 network, the park constitutes an important ecological

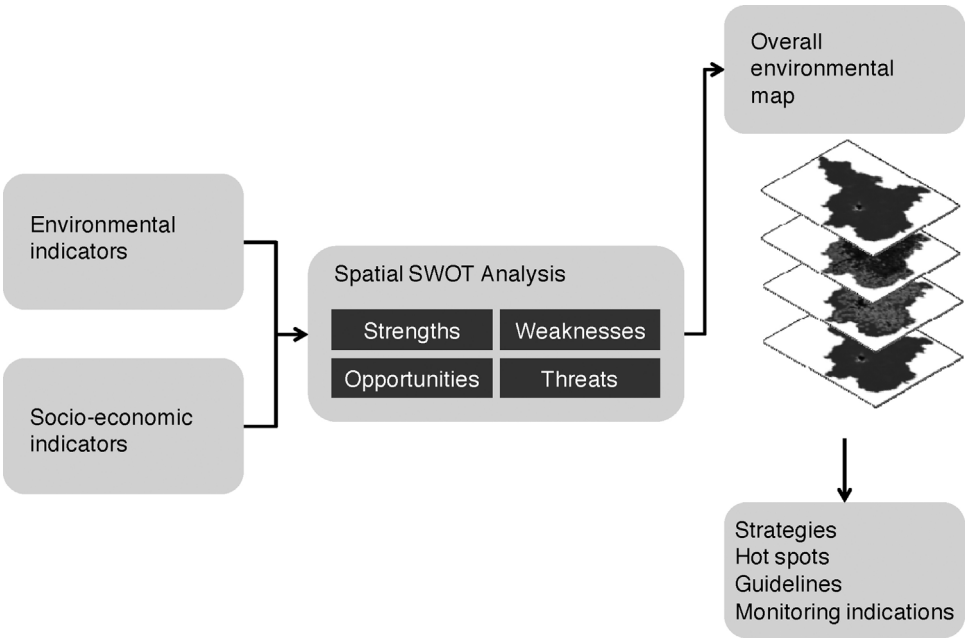

Fig. 3. Methodological flowchart for the analysis.

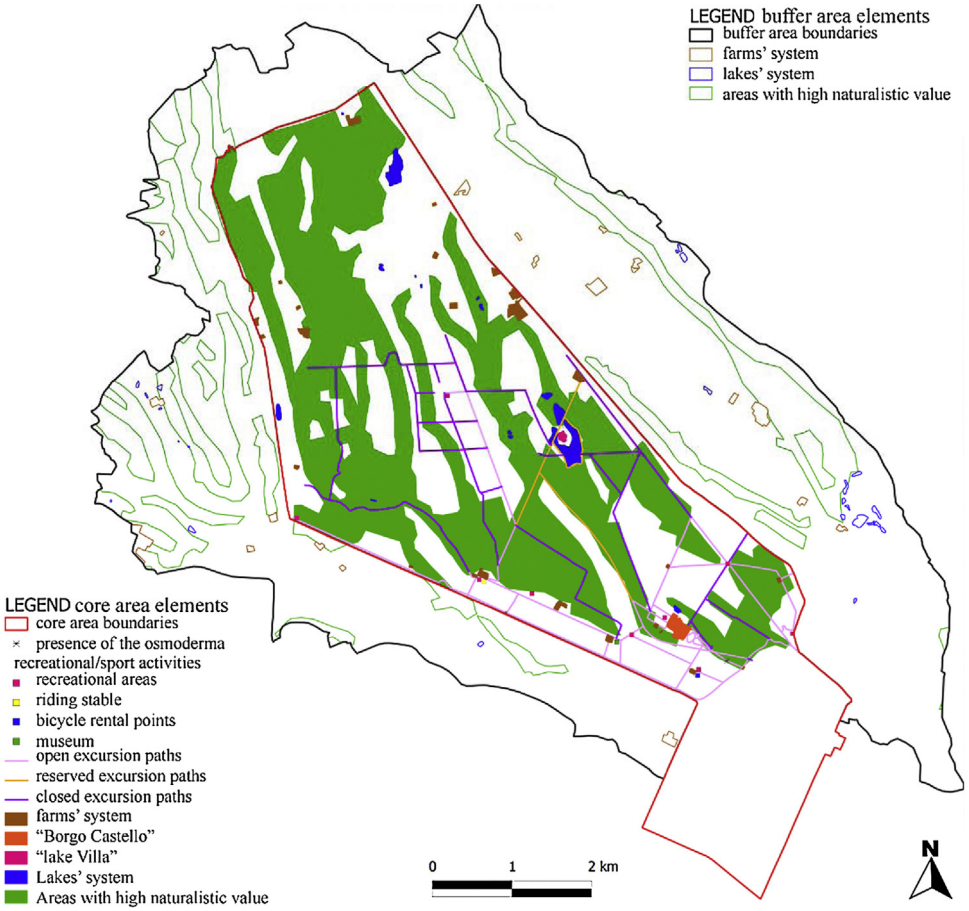

Fig. 4. The spatial SWOT analysis: Strengths spatial indicators.

Table 3
The SWOT analysis indicators.

Indicators	Category	Description	Unit of measure
The farms' system	S	The indicator considers the network of farms insisting on the area under analysis. Most of the farms have a high historical and architectural value and are partially used for touristic and recreational activities.	Number of farms recovered for touristic/educational purposes
The lakes and the "Lake Villa"	S	The area embraces three lakes of high naturalistic value: the "Cristoforo" lake, the "Strada" lake and the "Grande" lake. At the heart of the lakes' system is the "Lake Villa" which is a building of high historical value presently used as a location for various types of events.	m^2
The Museum of the Royal Apartments ("Borgo Castello")	S	The building was one of the royal houses of the Savoia family and now hosts the museum of the royal apartments. Moreover, the building is a UNESCO site.	Number of visits
Recreational/sports activities	S	This indicator takes into consideration all the elements that can have a recreational function inside the area under analysis (e.g. bicycle rental points, the riding stable, excursion paths, summer camps, picnic areas, etc.). These elements have already been designed in order to make sure that there are no negative impacts on the surrounding ecosystems.	Number/m^2
Areas with high naturalistic value	S	This indicator refers to the presence of valuable elements such as poplar and oak plantations and rows of *Quercus robur*. These lasts, in particular, have both a high naturalistic and historical value.	m^2
Presence of the "*Osmoderma eremita*" (Carpaneto et al., 2010; Ranius and Nilsson, 1997; Ranius et al., 2005)	S	This indicator refers to the presence of a species of beetle that, due to habitat loss and fragmentation, has decreased all over its distribution range. Its presence has been detected in the hollows of the *Quercus robur* rows and near the lakes.	Number of detected appearances
Farms to be repaired	W	This indicator refers to the presence of either abandoned or crumbling or risky farms inside the area under analysis. These farms need relevant restoration before being recovered for any use and the associated costs for the works are very high.	Number/m^2
Unsafe *Quercus robur*	W	This indicator refers to those trees in the historical boulevard at the main entrance of the park which are very old and thus unsafe. They need maintenance and reparation works and due to this reason it is often necessary to temporally close the central boulevard.	Number
Anthropic pressure areas	W	This indicator takes into account the presence of urban and industrial areas inside the park. Due to the activities taking place in these areas negative externalities can impact the park's ecosystems.	m^2
Cultivated land	W	This indicator considers the extension of agricultural land inside the area under analysis in order to take into account the negative pressures that it can generate on the surrounding ecosystems.	m^2
Private areas inside the park	W	This indicator takes into account the extension of private areas inside the park. These areas represent a weakness for both the integrated management and planning of the natural park.	m^2
Wetlands	W	This indicator is related to the high presence of *entomofauna* during summer time which makes the area and its services unlivable.	m^2
Proximity to the "Venaria royal palace"	O	This indicator refers to the presence of a very important attractor in the buffer area of the park which is the Venaria Royal Palace. This last has been declared by UNESCO property of humanity and attracts considerable amounts of tourists all year round.	Number of visitors
Golf Club	O	This indicator refers to the attractive role played by the Golf Club whose visitors might be interested in combining the experience with a visit to the Park.	Number of visitors
Public transport stops	O	This indicator refers to the possibility of reaching the Park by public transport mode, according to the international literature on sustainability.	m
Accessibility	O	This indicator takes into consideration the presence and distribution of entrances (for both pedestrians, bikes and cars) to the park.	Number
"Ceronda" stream	T	This indicator refers to the flood risk associated with the stream.	m^2 of flooded areas each year
"Stura di Lanzo" river	T	This indicator takes into account the flood risk associated with the river.	m^2 of flooded areas each year
Parking areas	T	This indicator refers to the risk of car congestion in the area under analysis.	m^2
"Magneti Marelli" industry	T	This indicator considers the presence of an industrial activity in the automotive sector in the buffer area of the park. This activity might represent a risk due to negative externalities on the park's ecosystems.	m^2
Hydrological risk	T	This indicator refers to the local constraints active in the area under analysis with reference to the hydrological risk.	m^2 of flooded areas and landslides each year

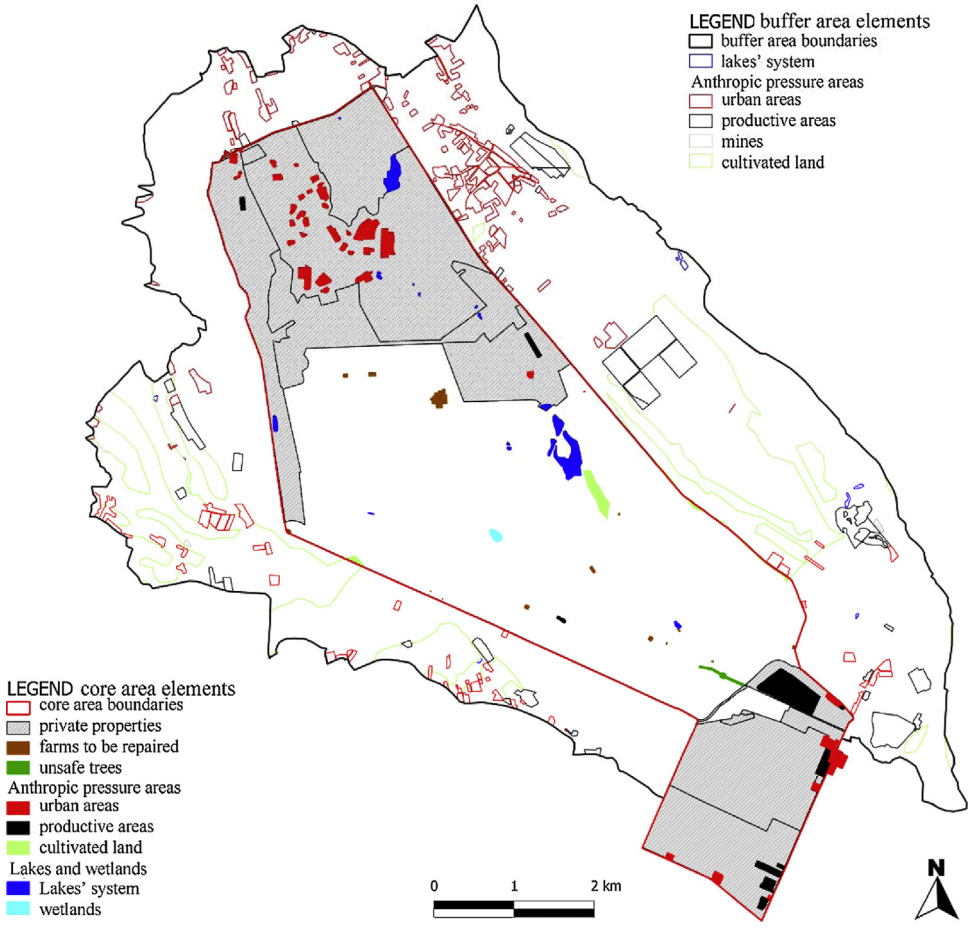

Fig. 5. The spatial SWOT analysis: Weaknesses spatial indicators.

corridor which connects the Alps to the Po hydrographic catchment (Regione Piemonte, 2014).

With its informative points, museums, didactic centers, the stable and farm with urban regional gardens the Park welcomes 1000–6000 visitors during summer days which become 500,000 visitors every year (Regione Piemonte, 2014). The park thus represents an example of the need to combine several potentially conflicting objectives, such as nature conservation, water resource protection, tourism and recreation, cattle grazing, preservation of outstanding geomorphologic sites, traditional landscapes and scenic views.

Consequently, the natural Park "La Mandria" has multiple functions. The interaction of preferences with the various services provided by a commodity generates a variety of values. Many economists have studied the nature of these values; however, a useful starting point is the concept of aggregate or Total Economic Value (TEV) (Pearce and Turner, 1990).

The most important reason for the economic appreciation of cultural and environmental resources is linked to their use. The use value of a commodity indeed constitutes a fundamental component of its overall value. The use value is linked to the utility perceived from the users of the commodity and can be categorized as direct use values (which are often partly reflected by market prices) and indirect use values (which generally have no market price description) (Pearce and Turner, 1990).

A unifying characteristic of these values is that they are all generated via the present use of the commodity by the valuing individual.

Dealing with environmental resources that typically represent public goods for which there isn't a market, other important components besides the instrumental or use values should be taken into account in the determination of the TEV. These last refer to the non use values and include:

- the option value, linked to the possibility of individuals valuing the option of future use;
- the existence value, linked to the possibility of preserving the good from a possible disruption;
- the bequest value, linked to the possibility for other generations and species to use the good.

The sum of use and non use values constitutes the Total Economic Value of a resource.

Therefore, valuing an environmental resource such as a protected park means to identify the different components of the overall value and their contribution to the TEV.

Fig. 2 shows how TEV can be broken down into its constituent parts with reference to the values generated by the natural Park "La Mandria".

The analysis of the values of the park through the methodological lens of the Total Economic Value approach allowed us to formally identify the objectives that will play a crucial role in the future management strategies of the Park. As a matter of fact, scientific research has demonstrated that the identification of fundamental objectives associated to a decision is not an easy task and that we often generate about half of the relevant objectives

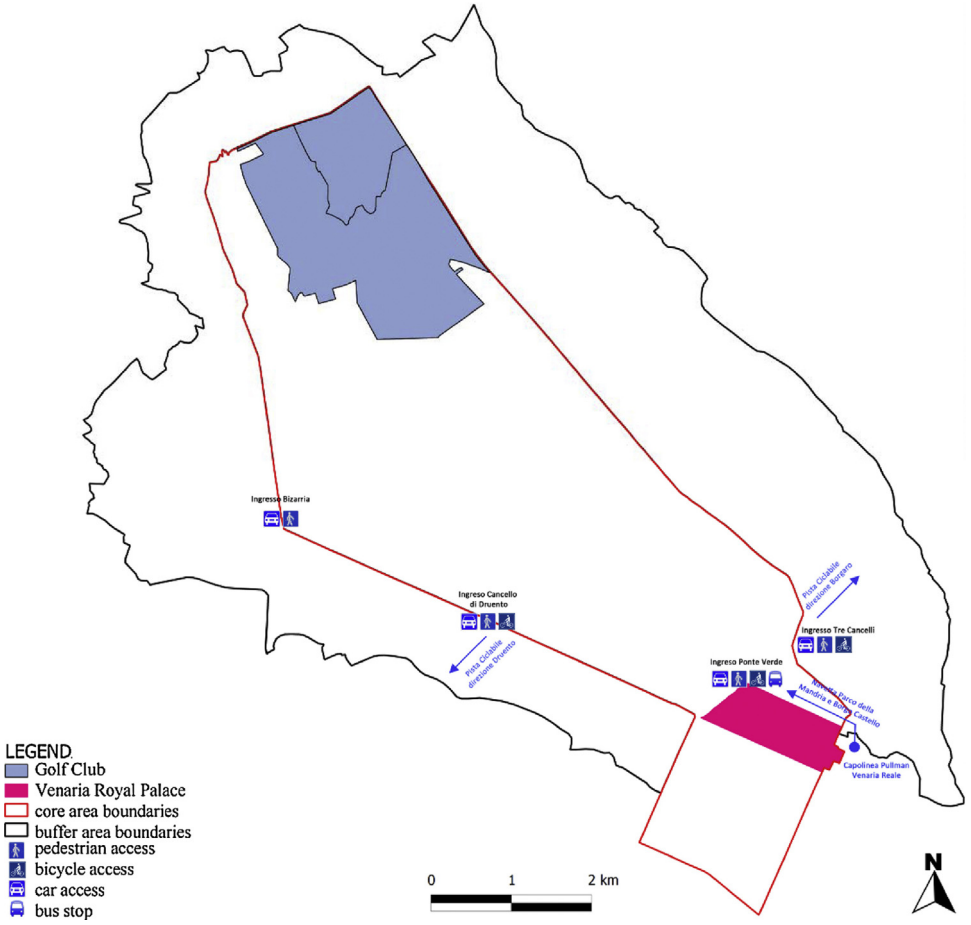

Fig. 6. The spatial SWOT analysis: Opportunities spatial indicators.

(Bond et al., 2008). The TEV approach in this case thus worked as a tool to formally support this strategic phase. The approach that we followed allowed us to implement in a novel way a value focused thinking (VFT) approach (Keeney, 1992) in a complex decision making context. Indeed, starting a planning and decision making process from the identification of values and objectives instead that directly from the alternative options has shown to lead to better decision (Keeney, 1992) but few attempts of implementing this approach with formal tools can be found in the environmental decision making context.

As a result, the objectives that the VFT/TEV approaches allowed us to identify for the management of the park can be summarized as follows:

(a) natural resources protection and valorization;
(b) promotion of the recreational use of the park;
(c) environmental and social education.

3. Environmental indicators and spatial SWOT analysis: methodological background

In recent decades, different methods and algorithms have been presented to support decision-making. In this respect, one of the most widely used orientations for measuring the sustainability of a system is the criteria and indicators approach (Pasqualini et al., 2011).

An indicator is a parameter associated with a phenomenon, which can provide information on the characteristics of the event in its global form (OECD, 2003). Its purpose is to indicate the state, or the variation in the state, of a phenomenon which cannot be measured directly. The problem is that alone an indicator provides little information unless it is associated with a system of indicators, able to provide systematic information for the purpose of assessment. A system of indicators consists of several indicators correlated from a logical and functional point of view, able to describe and provide information on several phenomena associated with each other, or which need to be interpreted in a coordinated way.

A key question thus concerns the way according to which the various indicators used to determine the multidimensional value of courses of action can be integrated to measure the sustainability of the transformation as a whole.

In order to properly analyze complex decision problems the need to integrate spatial data with algorithmic techniques has been recognized and has given rise to a research stream in the context of Decision Support Systems (DSS) related to the so-called Spatial Decision Support Systems (SDSS). As mentioned by Maniezzo et al. (1998), these systems concern the integration of spatially referenced information in a decision-making environment in order to positively affect the performance of Decision Makers, showing how spatially integrated DSS can be used to bridge the gap between policy makers and complex computerized models. Within this context a very fundamental role can be played by the integration of spatial information and the well known Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis.

As a matter of fact, almost any situation can be characterized in terms of positive and negative factors affecting its development, of both internal and external origin. Consequently the (SWOT) analysis is a commonly used tool for analyzing both environments in

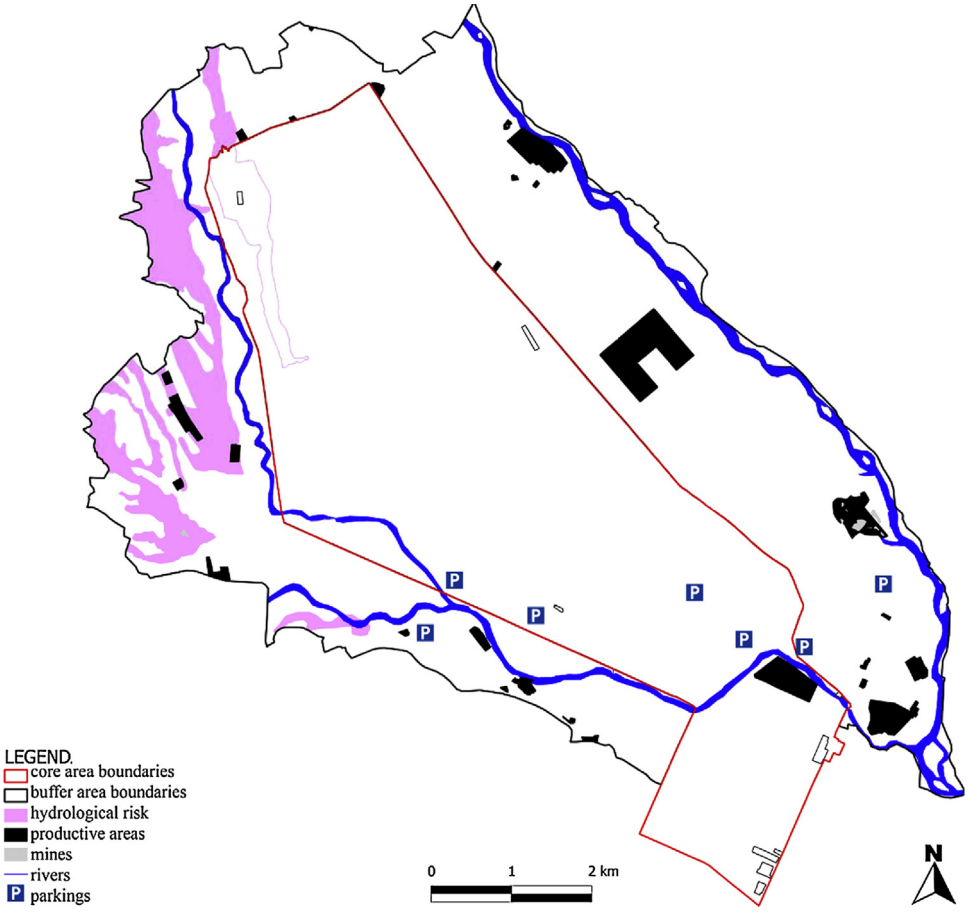

Fig. 7. The spatial SWOT analysis: Threats spatial indicators.

order to attain a systematic approach and support for a decision situation (Wheelen and Hunger, 1995; Kangas et al., 2003).

SWOT analysis was first used in the 1960s as a tool for business management, in contexts characterized by uncertainty and high competitiveness. In recent years the SWOT analysis has reached wider fields of application, and it is now commonly applied to support strategic planning procedures, to analyze alternative scenarios of urban and territorial development and to evaluate projects, plans and programs at both the local and global level. The SWOT analysis constitutes nowadays a well consolidated approach in the field of sustainability assessments thanks to its ability to represent in a rational and organized way the influence played by multiple factors on different decision contexts.

From the methodological point of view, the SWOT analysis allows to distinguish between:

- endogenous factors (i.e. variables that are part of the system and that can be directly modified);
- exogenous factors (i.e. variables that are external to the system but that can influence it; these variables cannot be directly modified but it is important to keep them under control in order to take advantage from the positive aspects and prevent negative consequences).

Table 1 provides a synthetic definition of the SWOT analysis components.

The SWOT analysis can be used as input to the creative generation of possible strategies, by asking and answering the following four questions numerous times:

- How can we use each strength?
- How can we stop each weakness?
- How can we exploit each opportunity?
- How can we defend against each threat?

When used properly, the SWOT analysis can provide a good basis for strategy formulation. However, the SWOT analysis could be used more efficiently than normally has been the case in its applications (McDonald, 1993). When using the SWOT approach, the analysis lacks the possibility of comprehensively appraising the strategic decision-making situation. It is often left at the level of only pinpointing the factors. In addition, the expression of individual factors is often of a very general nature and brief (Hill and Westbrook, 1997).

In this study, we show how SWOT analysis can be elaborated in order to provide a more comprehensive decision support tool, by spatially resolving the indicators, and linking them to specific values and objectives. The approach is applied to the management of a regional Park in Northern Italy that plays a relevant role in the green areas network due to the contemporary presence of multiple and high quality values referring to the following dimensions: (i) naturalistic, (ii) historical and (iii) architectural.

Nowadays Geographic Information Systems are becoming the basic tools to support spatially related decisions.

Spatial analysis represents a fundamental and complementary tool for the SWOT analysis because through the use of a GIS of the territory it is possible to take into account the spatial distribution of the indicators under analysis and to highlight environmental aspects and human interactions with the natural environment, thanks to the overlaying of thematic layers.

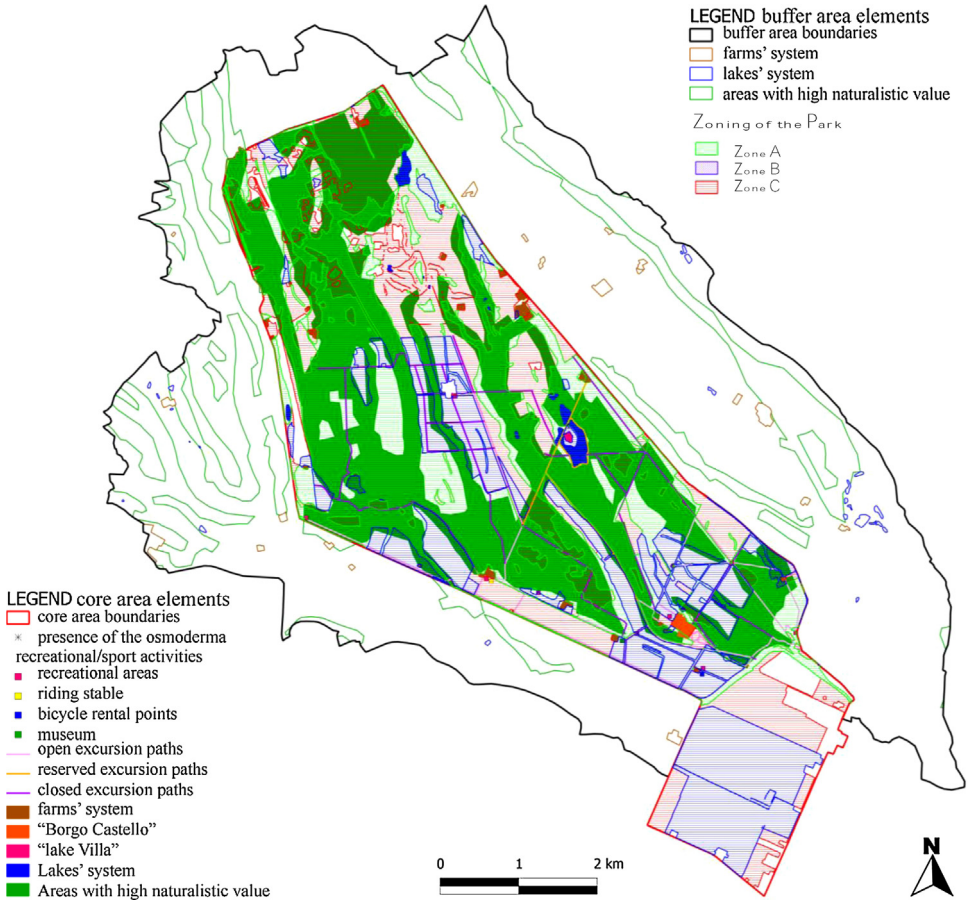

Fig. 8. Spatial overlay of Strengths and park zones A, B and C.

Following this procedure, a multi-attribute vector database can be established with reference to the 4 dimensions highlighted in Table 1.

Consequently, the objective of a spatial SWOT analysis, which becomes a spatial decision support tool is to provide comprehensive support early in the life cycle of a project/process/decision in order to strengthen and guide its development.

In particular, the method adopted to develop the spatial decision-support tool proposed in the present study consisted of the following three main stages, as illustrated in Fig. 3:

a. A SWOT analysis was carried out. The relevant factors of the internal and external environment have been identified and included in the SWOT analysis.
b. A spatial analysis through GIS has been carried out in order to take into account the spatial distribution of each indicator identified under the SWOT categories.
c. Strategic guidelines and indications for monitoring have been formulated based on the overall obtained maps.

Very few applications of the spatial SWOT analysis already exist in the international literature. The identified ones are reviewed in the following paragraph.

Geneletti et al. (2007) propose a spatial SWOT analysis to support a Strategic Environmental Assessment (SEA) procedure, highlighting data and scale issues for the application of the tool in this context. Sanò and Fierro (2003) used GIS to calculate the coefficients to be used in a quantitative SWOT analysis about coastal management options. They thus used GIS as an input to the SWOT. Also Huaizhi et al. (2010) proposed a combination of qualitative and quantitative methods for the development of a spatial SWOT to support regional function division of land use in a region in China.

With respect to the aforementioned literature, our approach proposes a full integration between the two tools and highlights the potential of this integrated approach at the municipal spatial scale, which has been less investigated in the existing literature.

Therefore, the present study has an innovative value since it represents one of the first investigation of the feasibility of this integrated approach in the context of strategic planning for multi-value natural resources. The potential contribution of this research lies in the experimentation of an integrated methodological framework that will stimulate new applications of similar tools in related as well as in different contexts.

4. The indicators-based spatial SWOT analysis for the royal natural park "La Mandria"

As highlighted in Section 2, the natural park "La Mandria" represents a strategic area characterized by an extraordinary value, from both the naturalist and the historical-architectural point of views.

Due to these reasons, the proper management and valorization of the park as a resource with multiple values represents both a priority and a challenge for the regional planning authority and for the management authority of the protected areas in the Turin's metropolitan area.

Based on a detailed survey of the available documents (e.g. internally produced reports, working papers, plans) concerning the "La Mandria" park management and specific projects aiming at its sustainable maintenance, the study developed through a series of 3 focus groups (2 for the definition and validation of the spatial SWOT

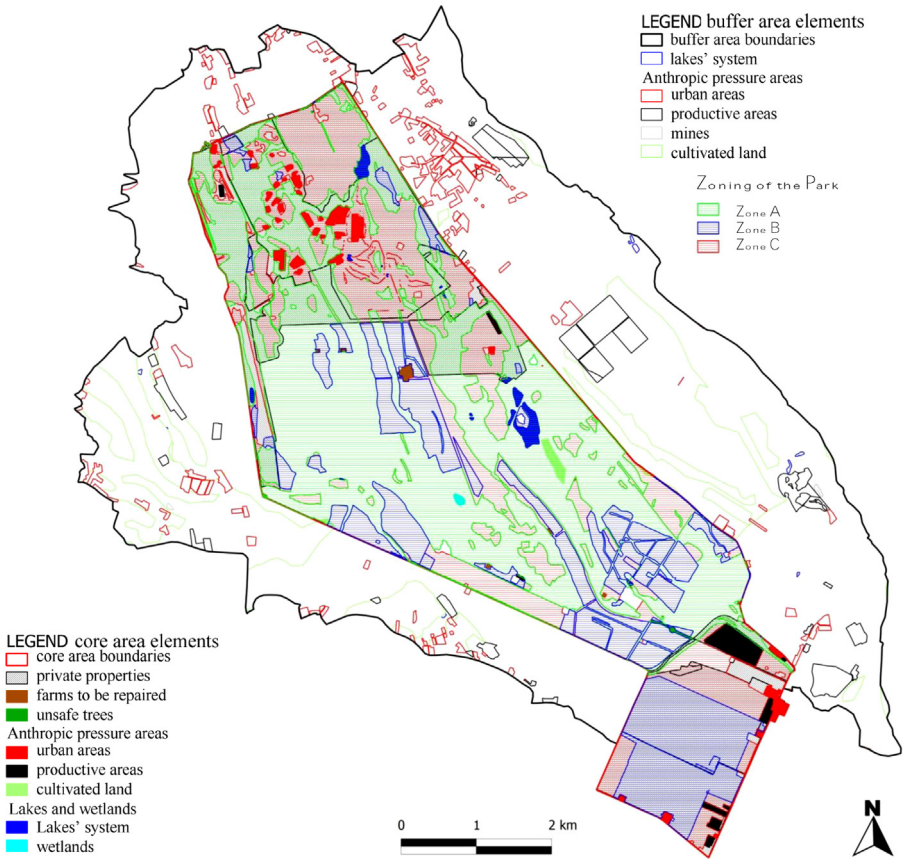

Fig. 9. Spatial overlay of Weaknesses and park zones A, B and C.

key indicators and 1 for the final presentation and discussion of the results obtained from the analysis) with both experts and decision makers. The experts involved in the process ranged from environmental engineers, to landscape ecologists, to architects, while the decision makers were the responsible people in the Park planning unit.

Although the traditional SWOT analysis is a simple and useful planning tool that can be used in many contexts, the complex territorial system under analysis represents a challenge for the application of planning support tools due to the aforementioned presence of multiple values and objectives. Indeed, the consequence of this characteristic is that the indicators that might be considered strengths/opportunities to one value (e.g. recreational opportunities) could simultaneously be considered as a weakness/threat to another value (e.g. biodiversity). Collaborative planning processes can help to tackle this challenge. As a consequence, in this study different focus groups were organized in order to discuss the nature of each indicator and obtain at the end a shared decision about its belonging category. This decision is the result of a group perspective on the problem, rather than on a single, subjective, perspective. In particular, in order to support a learning and convergent process among the participants, we used a facilitated modeling approach, i.e. we structured and defined the nature of the problem situation in a dynamic and interactive way together with the decision makers/clients, thus supporting discussion among participants, exchange of different arguments, learning and shared development of plans for subsequent implementation.

From the methodological point of view it is important to underline that the collaborative environment in which the experts' panels meetings took place allowed to agree also on the boundaries, both geographical and administrative, of each of the four key concepts of the spatial SWOT analysis. In particular, the strengths and weaknesses, being defined as internal factors, have been assessed by considering the indicators which, from the geographical point of view belong to the park "core area" (as explained in Section 2), and from the administrative point of view represent an internal competence of the Park authority. On the other hand, the opportunities and threats, being defined as external factors, were associated to those indicators which, from the geographical point of view belong to the park "buffer zone", and from the administrative point of view represent the competence of an external authority.

Table 2 presents the results of the SWOT analysis while Table 3 provides for each identified indicator the category to which it belongs, a brief description and its unit of measure.

The unit of measure in the last column of Table 3 is the result of a proposal formulated by the focus group of both real stakeholders and experts who participated in the spatial SWOT analysis development process and is intended to support both the definition and the use of future monitoring plans for the management of the park and for its new zonation.

As explained in Section 3, each indicator identified in the SWOT analysis has been further investigated with reference to its geographical characteristics. The added value of this investigation lies in the possibility to identify spatial correlations among the different aspects considered in the analysis (as will be discussed in Section 5). In particular, the results consisted in thematic maps of the different indicators of the SWOT analysis, as well as in overall maps for each area of concern. Figs. 4–7 show the result of the spatial SWOT analysis.

The overall maps illustrated in Figs. 4–7 provide an overview of the distribution of critical elements and represent a framework to support the forthcoming strategic planning phase and the proposal of additional Plan's regulations. In particular, such new provisions

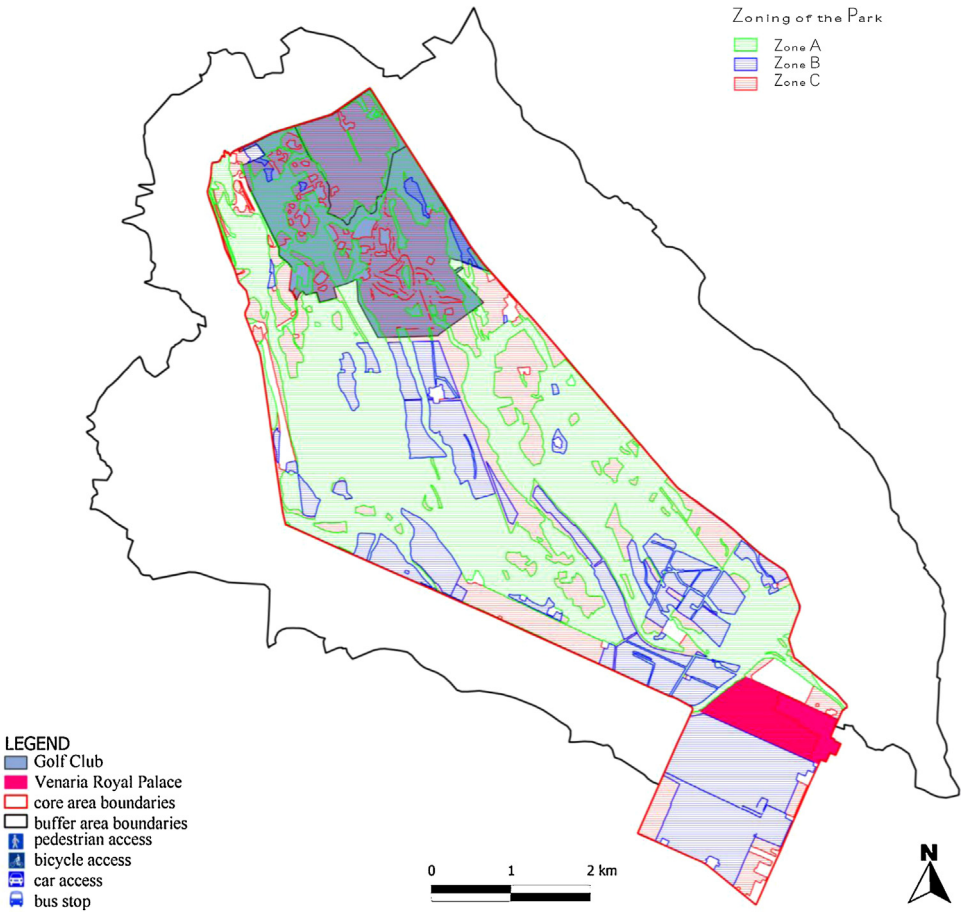

Fig. 10. Spatial overlay of Opportunities and park zones A, B and C.

will aim at avoiding development that increases threats and at promoting development that fosters the opportunities.

Moreover, the detailed analysis and discussion of the overall maps together with the Park authority allowed to identify management interventions priorities, as described in Section 5.

5. Results and discussion

The results of the spatial SWOT analysis allowed to identify the most vulnerable components of the territory (Weaknesses) that need defense intervention and monitoring measures and the environmental and physical factors that suffer the highest human intervention impact (Threats), as well as the most valuable areas (Strengths and Opportunities) inside the region under investigation, for which monitoring and protection measures should be envisaged.

Through the analysis of the obtained maps it is possible to derive operational guidelines about where and how to constrain land use in order to ensure sustainable use of land in a protected area characterized by exceptional and multidimensional values (Figs. 1 and 2).

Other interesting indications to support the strategic planning and management phase of the Park arose from a more comprehensive analysis of the spatial SWOT results combined with the existing zonation of the Park, through which specific uses are assigned to land units. According to the law provisions, the park is zoned into three protection levels, ranging from strict nature conservation (core area) to gradually more intensive human presence and activities such as promotion of tourism and recreation. In particular, consistently with the Italian Framework law on protected areas, the Natural Park La Mandria is divided into three main protection levels, or "zones":

- Zone A (or "Riserva integrale"): strict protection of the environment and the ecosystems, minimizing presence of or disturbance by human activities.
- Zone B (or "Riserva guidata"): protection of cultural, historical and landscape assets, restricting land use to traditional activities that are considered not harmful for the environment.
- Zone C (or "Riserva controllata"): minimizing the disturbance to environment as much as possible, but stimulating recreational use and development of tourist facilities.

Protected area zoning is a decision-making issue that inherently requires the evaluation of multiple land attributes according to multiple objectives and thus represents the most relevant process in park planning (Geneletti and Van Duren, 2008).

To this end, the results of the spatial SWOT analysis have been overlaid with the existing zonation of the Park, as shown in Figs. 8–11.

The spatial overlay of the SWOT indicators with the different protection zones of the Park allowed to verify the coherence and the sustainability of the management of the Park and to identify warning spots needing specific recovery or monitoring measures.

In particular, with reference to the Strengths of the Park (Fig. 8), it is possible to notice that there is a strong coherence between the geographical distribution of the indicators and the different protection zones. The natural valuable areas (e.g. woods, poplar plantations, etc.), the lakes' system and the most valuable paths all fall within the boundaries of zone A (strict protection), while

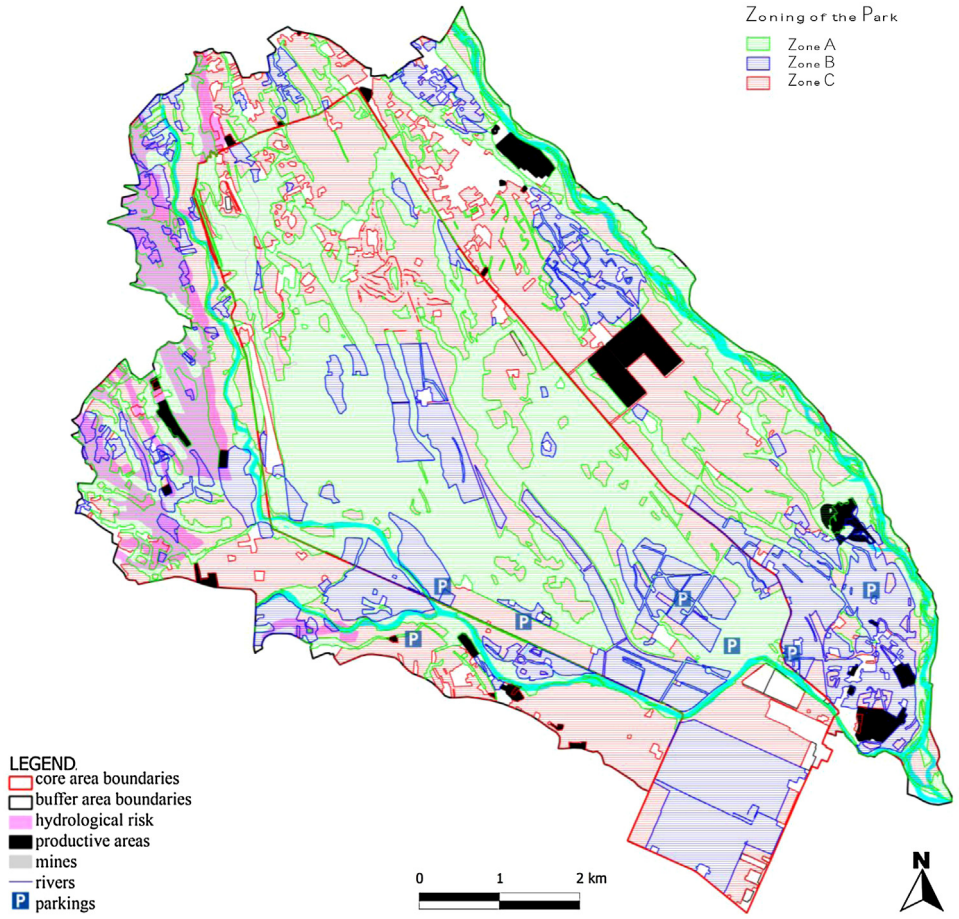

Fig. 11. Spatial overlay of Threats and park zones A, B and C.

the farms and the recreational paths fall within the boundaries of zones B and C (where human presence and activities are allowed). This shows a first positive evidence about the good management practice adopted by the Park so far.

With reference to the Weaknesses of the Park (Fig. 9), the overlay shows that there are some warning spots (i.e. the presence of cultivated areas inside zone A and the existence of a productive area adjacent to zone A) needing adequate monitoring measures. In this case the analysis allowed to highlight the necessity of planning buffer zones between zone A and zones B and C. In particular, the park management and planning units showed an interest in monitoring these spatial indicators regularly in order to contain as much as possible the expansion of cultivated and productive areas inside the park.

With reference to the Opportunities highlighted for the Park (Fig. 10), the overlay shows a good coherence between the geographical distribution of the indicators and the different protection zones. Nevertheless, particular attention in the forthcoming strategic planning phase for the sustainable management of the Park should be devoted to the predisposition of monitoring measures for the Golf Club areas falling within the boundaries of zone A. The future strategy agreed by the park managers will consist in involving the Golf Club in the future monitoring of the impacts and environmental pressures arising from the Golf Club activities on the surrounding area through a participatory approach.

Finally, with reference to the Threats identified for the Park (Fig. 11), it is possible to notice a strong coherence between the geographical distribution of the indicators and the different protection zones. In particular, the industrial areas fall within the boundaries of zone C while the two rivers and the areas characterized by hydrological risk fall within the boundaries of zone A. As in the case of the weaknesses, again the park management and planning units showed a strong interest and willingness to spatially monitor the areas subject to hydrological risks in order to avoid recreational activities in the dangerous areas.

The tool developed in the present research allowed to obtain useful indications and guidelines to support the forthcoming review of the management plan of the Park and its zones validation. Decision support tools such as a spatial SWOT analysis have demonstrated to play a crucial role during the strategic phase of territorial planning for protected areas where most information has a spatial component (Herwijnen, 1999).

Within the context of environmental planning and land management, planners and managers indeed need to evaluate the spatial distribution of land properties, and decide upon where to restrict or stimulate certain activities or where to implement measures to protect natural resources.

It is worth highlighting that one of the most important results obtained in this study is represented by the fact that the actors and experts who participated in the focus group for the development of the spatial SWOT analysis acknowledged the following aspects of the overall process: (i) the spatial SWOT analysis development generated greater awareness of the esthetical and functional aspects of the park for all the actors; (ii) the framework allowed the actors to agree on a shared vision to efficiently manage the available resources, and (iii) the process inspired the development of new strategies and monitoring plans for the park.

6. Conclusions

This paper presented an approach to construct a spatial planning support system aimed at providing useful guidance to both researchers and practitioners working in the field of environmental resources management. The approach was tested using a real case study, i.e. the "La Mandria" natural Park in close cooperation with regional experts and park's officers. Through this study, we aimed at suggesting to park's managers and other stakeholders an approach that is scientifically sound and practical. Moreover, to promote transparency and facilitate communication with stakeholders (Geneletti and Van Duren, 2008) a clear step-by-step methodology has been adopted.

To start with, the use of the Total Economic Value framework in the context of the Value Focused Thinking (Keeney, 1992) approach allowed us to support in an efficient way the initial challenging phase of objectives definition for the subsequent development of the SWOT analysis. The combined framework seems indeed a very promising approach in the field of environmental decision making and natural resources management, for which the values at stake are typically of both use and non-use nature.

In particular, the SWOT mapping has contributed to the planning of zoning modifications (i.e. the boundaries of developable land and size thresholds), as well as mitigation and compensation measures (e.g. proposal of energy efficiency standards for new recreational areas inside the Park) and monitoring plans to ensure a sustainable use of the Park.

The results of the analysis will inform the creation of a set of suitable strategy alternatives.

Future developments of the research refer to the possibility of combining Multicriteria Decision Aiding (MCDA) methods (Figueira et al., 2005; Ferretti and Comino, 2015) with the spatial SWOT analysis in order to obtain, through an holistic approach, analytical priorities for the factors included in the SWOT analysis and make them comparable.

The approach proposed in the present research succeeded in representing the complexity of the system under analysis, taking into account its multiple values and functions that all together form the Total Economic Value of an environmental resource. Therefore, this approach can be interesting for other parks at the European level where there is a need to establish or update their zoning scheme and where multiple values have to be taken into account at the same time. Nevertheless, it is worth noting that according to the SWOT analysis approach, Strengths, Weaknesses, Opportunities and Threats are always considered from a certain perspective, interest or objective. The challenge in the context of complex territorial systems, as the one illustrated in the present paper, lies in the presence of multiple uses and thus competing claims which characterize some developments as an opportunity from one perspective (e.g. economic development) and as a threat from another perspective (e.g. nature conservation). In order to tackle this challenge, the present study developed the spatial SWOT framework by means of focus groups with experts in different fields ranging from environmental engineering to landscape ecology and architecture in order to build a shared vision about each indicator and its respective belonging category.

In this context, a second future line of research will investigate the robustness of the proposed approach (Tsoukiàs et al., 2013; Boerboom and Ferretti, 2014). In our case, robustness concerns the process being developed, rather than the obtained results. In this sense, what other similar as well as different parks could replicate is the overall methodological approach, which has shown to be helpful and effective, while the specific spatial indicators will have to be selected and adapted each time depending on the specific context under analysis.

Finally, based on the obtained results, current developments of this research are exploring the use of Choice Experiments (Tagliaferro et al., 2013) for designing requalification alternatives of the abandoned farms' system located inside the park, which has shown to be both a strength and a weakness of the territorial system under analysis. In particular, based on the Total Economic Value framework used for the definition of the objectives of the Park (Fig. 2), we are investigating the willingness to pay of different categories of users for alternative requalification strategies involving the farms (e.g. recreational versus cultural use, single requalification versus system creation, public versus private management, etc.).

In conclusion, the combined use of GIS (i.e. the spatial distribution of impacts and factors) and SWOT Analysis seems a very promising line of research for supporting strategic decision-making processes. Taking into account the spatial distribution of the SWOT indicators helps decision makers to analyze the situation more precisely and in more depth than is the case with the standard SWOT. Moreover, another added value of the adopted approach refers to the possibility of providing useful indications and priorities on how and where to spend the available money allocated for the management of the natural Park.

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References

Bateman, I.J., Lovett, A.A., Brainard, J.S., 2003. Applied Environmental Economics. A GIS Approach to Cost-Benefit Analysis. Cambridge University Press, UK.

Boerboom, L., Ferretti, V., 2014. Actor network theory perspective on a forestry decision support system design. Scand. J. Forest Res. 29, 84–95, http://dx.doi.org/10.1080/02827581.2014.946960.

Bond, S., Carlson, K., Keeney, R., 2008. Generating objectives: can decision makers articulate what they want? Manage. Sci., 56–70.

Carpaneto, G.M., Mazziotta, A., Coletti, G., Luiselli, L., Audisio, P., 2010. Conflict between insect conservation and public safety: the case study of a saproxylic beetle (*Osmoderma eremita*) in urban parks. J. Insect Conserv., http://dx.doi.org/10.1007/s10841-010-9283-5.

Chiesura, A., 2004. The role of urban parks for the sustainable city. Landsc. Urban Plan. 68, 129–138.

De Groot, R.S., Wilson, M.A., Boumans, R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecol. Econ. 41, 393–408.

European Environment Agency, 2009a. Common Database on Designated Areas (CDDA), http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=1047 (accessed 08.01.14).

European Environment Agency, 2009b. European Nature Information, http://eunis.eea.europa.eu (accessed 08.01.14).

European Environment Agency, 2009c. Nationally Designated Areas (National CDDA), http://eea.europa.eudata-andmaps/data/nationally-designated-areas-national-ccd-4 (accessed 08.01.14).

Ferretti, V., Comino, E., 2015. An integrated framework to assess complex cultural and natural heritage systems with Multi-Attribute Value Theory. J. Cult. Heritage 16, 688–697, http://dx.doi.org/10.1016/j.culher.2015.01.007.

Ferretti, V., Pomarico, S., 2013. Ecological land suitability analysis through spatial indicators: an application of the Analytic Network Process technique and Ordered Weighted Average approach. Ecol. Indic. 34, 507–519.

Figueira, J., Greco, S., Ehrgott, M. (Eds.), 2005. Multiple Criteria Decision Analysis: The State of the Art Surveys. Springer Science + Business Media Inc., NY, USA.

Fisher, B., Turner, K.R., Morling, P., 2009. Defining and classifying ecosystem services for decision making. Ecol. Econ. 68, 643–653.

Geneletti, D., Bagli, S., Napolitano, P., Pistocchi, A., 2007. Spatial decision support for strategic environmental assessment of land use plans. A case study in southern Italy. Environ. Impact Assess. Rev. 27, 408–423.

Geneletti, D., Van Duren, I., 2008. Protected area zoning for conservation and use: a combination of spatial multicriteria and multiobjective evaluation. Landsc. Urban Plan. 85 (2), 97–110.

van Herwijnen, M., (PhD thesis) 1999. Spatial Decision Support for Environmental Management. Vrije Universiteit Amsterdam.

Hill, T., Westbrook, R., 1997. SWOT analysis: it's time for a product recall. Long Range Plan. 30, 46–52.
Huaizhi, T., Kening, W., Min, T., 2010. Research on regional function division of land use in Taiyuan City. In: International Conference on Electronics and Information Engineering (ICEIE 2010), vol. 2, pp. 283–287.
IUCN-UNEP, 2010. The World Database on Protected Areas (WDPA), http://www.unep-wcmc.org/world-database-on-protected-areas-wdpa_76.html (accessed 20.01.14).
Kangas, J., Kurttula, M., Kajanus, M., Kangas, A., 2003. Evaluating the management strategies of a forestland estate – the S-O-S approach. J. Environ. Manage. 69, 349–358.
Keeney, R.L., 1992. Value-Focused Thinking. A Path to Creative Decision Making. Harvard University Press, Cambridge.
Marcer, A., Garcia, V., Escobar, A., Pons, X., 2010. Handling historical information on protected-area systems and coverage. An information system for the Natura 2000 European context. Environ. Model. Softw. 25, 956–964.
Maniezzo, V., Mendes, I., Paruccini, M., 1998. Decision support for siting problems. Decis. Support Syst. 23, 273–284.
McDonald, M.H.B., 1993. The Marketing Planner. Butterworth-Heinemann, Oxford.
OECD – Organization for Economic Co-operation and Development, 2003. OECD Environmental Indicators. Development, Measurement and Use, Working paper.
Pasqualini, V., Oberti, P., Vigetta, S., Riffard, O., Panaıotis, C., Cannac, M., Ferrat, L., 2011. A GIS-based multicriteria evaluation for aiding risk management *Pinus pinaster* Ait. forests: a case study in Corsican Island, Western Mediterranean region. Environ. Manage. 48, 38–56.
Pearce, D.W., Turner, R.K., 1990. Economics of Natural Resources and the Environment. Harvester Wheatsheaf, New York.
Phua, M.H., Minowa, M., 2005. A GIS-based multi-criteria decision making approach to forest conservation planning at a landscape scale: a casa study in the Kinabalu Area, Sabah, Malaysia. Landsc. Urban Plan. 71, 207–222.
Ranius, T., Nilsson, S.G., 1997. Habitat of *Osmoderma eremita* Scop. (Coleoptera: Scarabaeidae), a beetle living in hollow trees. J. Insect Conserv. 1, 193–204.
Ranius, T., Aguado, L.O., Antonsson, K., Audisio, P., Ballerio, A., Carpaneto, G.M., Chobot, K., Gjurašin, B., Hanssen, O., Huijbregts, H., Lakatos, F., Martin, O., Neculiseanu, Z., Nikitsky, N.B., Paill, W., Pirnat, A., Rizun, V., Ruic|nescu, A., Stegner, J., Süda, I., Szwako, P., Tamutis, V., Telnov, D., Tsinkevich, V., Versteirt, V., Vignon, V., Vögeli, M., Zach, P., 2005. *Osmoderma eremita* (Coleoptera, Scarabaeidae, Cetoniinae) in Europe. Anim. Biodivers. Conserv. 28, 1.
Regione Piemonte, 2014. Parco Naturale La Mandria, http://www.parchireali.gov.it/parco.mandria/ (accessed 8th January).
Sanò, M., Fierro, G., 2003. Integration of the SWOT Analysis as a Coastal Management Tool With a Geographical Information System: Two Approaches to the Problem and First Results. Dipartimento per lo studio del Territorio e delle sue Risorse (Dip. Te. Ris.), Università di Genova (IT), University of Georgia, Working paper.
Solecki, W.D., Welch, J.M., 1995. Urban parks: green spaces or green walls? Landsc. Urban Plan. 32, 93–106.
Tagliaferro, C., Longo, A., van Eetvelde, V., Antrop, M., Hutchinson, W.G., 2013. Landscape economic valuation by integrating landscape ecology into landscape economics. Environ. Sci. Policy 32, 26–36.
Tsoukiàs, A., Montibeller, G., Lucertini, G., Belton, V., 2013. Policy analytics: an agenda for research and practice. EURO J. Decis. Processes 1 (1), 115–134.
Wheelen, T.L., Hunger, J.D., 1995. Strategic Management and Business Policy. Addison-Wesley, Reading, MA.