MAPPING STAKEHOLDERS PERCEPTION ON ECOSYSTEM SERVICES PROVISION WITHIN THE PORTUGUESE SOUTHWEST ALENTEJO AND VICENTINE COAST NATURAL PARK

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ABSTRACT

The last decades have seen a growing interest of scientists and policy makers on the assessment of ecosystem services. Among assessment tools, participative mapping of ecosystem services appears as an interesting though still not much explored tool for protected areas planning and management.

In this article we evaluate the potential of these methodologies to assess the supply of ES by different land uses in the Southwest Alentejo and Vicentine Coast Natural Park (SAVCNP), located in the SW corner of Portugal. Through this work, developed with key stakeholders from the area, we identified the most relevant ecosystem services, their trends and underlying drivers. Building on this data, we undertook a collaborative mapping exercise to identify hotspots for ten different ecosystem services.

These processes provided valuable information that together with scientific based data will support decision making for conservation in territorial planning, namely through the Municipal and Park's Management Plans. Additionally, the engagement of local stakeholders promoted awareness raising, social learning and knowledge exchange. Finally, the potential of these tools to support a more targeted, dynamic and adaptable planning of protected areas is discussed.

Keywords: Coastal areas; Ecosystem services; Participatory GIS; Protected areas; Stakeholder; Perception.

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1. INTRODUCTION

The concept of Ecosystem Services (ES), understood as “the benefits people obtain from ecosystems” (Millennium Ecosystem Assessment 2005), has been attracting a growing interest in scientific literature and policy-making (García-Nieto *et al*., 2013; Palomo *et al*., 2013).

This concept, that emerges as a new approach to address the loss of biodiversity (Hauck *et al*., 2013), gains significance in a context in which the effectiveness of a conservation model based on isolated reserves is increasingly contested (Barber *et al*., 2004; Toledo, 2005; Guevara and Laborde, 2008). It is argued that Protected Areas (PAs) are threatened by land use intensification around and within these areas, as a result of which, there is a decline of ecosystems capacity to preserve complex ecological functions and biodiversity (Marull *et al*., 2010). Population growth, urbanization, climate change and habitats fragmentation, are some of the threats urging to increase PAs resilience through their connection with surrounding natural and semi-natural areas (Worboys, 2010), and to enhance PAs integration in their social, economic and ecological contexts (Rodríguez-Rodríguez, 2012). As stated by Palomo *et al*. (2014), for PAs to effectively play their role, the relationship with the surrounding territories and a balance between conservation aims and human needs need to be considered. This is particularly important in human-dominated landscapes such as those in Southern Europe. In this context, the ES concept may potentially respond to the needs for a more integrated approach to ecosystems and for a balance between human needs and conservation, as it represents the interaction of ecological and social spheres.

However, the implementation of the ES concept faces the problem of its difficult assessment due to data deficiencies (Burkhard *et al*., 2009; Dick *et al*., 2014). Mapping techniques are a common approach, showing great potential as a support tool for landscape management and environmental decision-making (Burkhard *et al*., 2012; Martínez-Harms and Balvanera, 2012; García-Nieto *et al*., 2013; Palomo *et al*., 2013). The spatial identification of areas of high ES supply, or the identification of trade-offs and synergies between ES, are some advantages of mapping (Martínez-Harms and Balvanera, 2012).

Another significant trend in PAs design and management has been an increasing focus on participatory approaches, since the non-inclusion of local populations has frequently led to their opposition (Vinuesa, 2007). Participation has also gained relevance in ES assessment, as perceptions are considered as important to understand the relevance given by society to ecosystems and their functions (Groot *et al*., 2002), and its influence on landscape change (García-Llorente *et al*., 2012). Interviews, questionnaires, workshops and mapping are some of the methodologies used for the integration of social values in ES assessment (García-Nieto *et al*., 2015).

2. OBJECTIVES

The goal of this article is to explore the potential of two different ES mapping methodologies. For that, we focus on the mapping of ES supplied by the Southwest Alentejo and Vicentine Coast Natural Park (SAVCNP), based on the perceptions of local stakeholders. This research is part of a larger project, OPENNESS, which ultimate aim is to operationalize the concepts of Natural Capital (NC) and Ecosystem Services (ES).

In the following sections the methodological approach is introduced, describing the different stages for the identification, assessment and representation of ES provision in SAVCNP. The main results of these exercises are then presented and explained. The article finishes with a discussion and final conclusions on the usefulness of the two methodologies explored, and their implications for the planning and management of protected coastal and marine areas.

3. METHODS

3.1 Study area

The Southwest Alentejo and Vicentine Coast Natural Park (SAVCNP) was created in 1995. Located in the South-western corner of Portugal, this park covers a coastal strip composed of 60.567 ha of land and 28.858 ha of marine waters. The coastline is characterized by elevated cliffs, deep ravines, small beaches, temporary water courses, estuaries and marshes, hosting a large diversity of habitats. The SAVCNP represents one of the few remaining well-preserved coastlines in Western Europe.

Figure 1 - Location of the SAVCNP.

However, this area faces several pressures. First, the spread of invasive species (e.g. *acacia and hottentot fig*) is contributing to the degradation of some habitats. Additionally, there are some polluting activities, namely large areas of irrigated agriculture located within SAVCNP and some industries in its vicinity. On the contrary, despite the spread of tourism activities, the regional promotion of a nature based model, the restrictions imposed by the park regulations and the advent of the economic crisis, have slowed down the development of massive tourism infrastructure. There is also some degree of conflict between the park management plan and local stakeholders, who consider it somehow inadequate and not flexible enough to accommodate local economic activities.

3.2 Study design

The research was structured around three main stages. During a preliminary stage, a comprehensive documentary review was conducted to identify potential ES existing in the case study area. At this stage, key regional stakeholders were also selected. The second and third stages were implemented, exploring two different methodologies for the mapping of ES supply within SAVCNP based on stakeholders' perceptions.

The first of these mapping methodologies is mostly based on the works of Burkhard *et al.* (2009) and Burkhard *et al.* (2012). The approach presented by these authors lays on the idea that the capacity of a given ecosystem to supply ES, depends on natural conditions (vegetation, soil, climate, etc.) and human impacts (land use, pollution, etc.). Considering the difficulty of their identification and quantification, they propose the use of experts' evaluations to overcome these limitations. For that, the authors resort to experts' evaluations on a 0-5 scale to assess the ES supply capacity of different land use categories. A matrix is then built using these values, where the intersection represents the capacity of land use X to supply the ES Y. These values are then connected to GIS spatial data (e.g. Corine Land Cover) and mapped.

The second methodology referred is inspired in the works of Bryan *et al*. (2010) and Martín-López *et al*. (2014). These authors propose to undertake collaborative mapping exercises with key stakeholders, to identify, among other aspects, those areas most important for the supply of a given ES. The maps collaboratively produced are then scanned, digitalized and processed to produce different indexes.

3.3 Identification of preliminary Ecosystem Services and key stakeholders

Based on the Common International Classification of Ecosystem Services (CICES) developed by the European Environment Agency, 22 ES were selected after a thorough literature review on the case study area. This list (table 1) was considered a starting point for subsequent assessments.

The next step targeted the identification of key stakeholders in SAVCNP that would undertake the assessment of these ES. Based on a documentary review of the case study area, a preliminary list was drawn up. Individual interviews were then held with those stakeholders. As of these meetings, other potential members were identified and interviewed using a snowball sampling technique.

Seven stakeholders were established as core actors of an Advisory Board (table 2), including the main sectors of activity as well as some stakeholders of strategic relevance due to their social capital. The goal of this body was to support research through a comprehensive knowledge of the regional context and to enrich the research knowledge base, whilst enhancing the project adaptation to territorial needs.

3.4 Mapping of perceived Ecosystem Services based on a spreadsheet method

During a second round of meetings, individual semi-structured interviews were conducted. The central goal of these interviews was a first approach to the identification and assessment of ES supplied by the ecosystems existing in SAVCNP. Once the degree of familiarity with the ES concept was addressed, the core of the questionnaire was organized in two parts.

The first one presented the above referred list of 22 ES to the interviewees, who were then asked to classify each ES using a 5-point Likert scale, ranging from 'none' to 'very high', according to their perception on '*which is the current capacity of supply of these different ES by the ecosystems included in the park?*'. The second part asked them to do the same evaluation but according to their perception on: '*which is the current capacity of supply of these different ES* by each of the main land use categories of the park?'

Table 1 - List of the 22 Ecosystem services considered in the research

PROVISIONING	REGULATING	CULTURAL
Agriculture and livestock	Assimilation and degradation of waste and toxics (in soil, water, atmosphere) by the ecosystem	Recreation and tourism
Gathering	Erosion prevention, and soil and coastal stabilization	Scientific and environmental education
Fishing, hunting, shell fishing and aquaculture	Water supply and flow regulation	Cultural heritage and traditions
Fibres and other materials	Pollination, seed dispersal	Aesthetic
Freshwater for domestic, agricultural or industrial use	Provision of habitats for nursery and reproduction	Existence
Wood fuel or plants/algae for energy use	Formation and maintenance of soil fertility	
Renewable abiotic energy sources	Water quality regulation	
Minerals	Global climate regulation by reducing GHG	
	Micro and regional climate regulation	

Table 2 - Members of the Advisory Board

Southwest Alentejo and Vicentine Coast Natural Park (SAVCNP) administration
Associação Rota Vicentina – a non-profit association promoting a nature tourism model of development in the region
Associação Armadores Pesca Artesanal Costa Vicentina – the association of regional fishermen and shell-fishermen
Liga para a Protecção da Natureza – an environmental NGO
Administração da Região Hidrográfica Alentejo (ARH) - the river basin district administration in Alentejo region
Associação Benificiários do Mira – the regional farmers association
Environmental consultant and local activist

As supporting material to this questionnaire, panels of ES (table 1) and land use categories (table 3) were provided. To facilitate their identification and understanding, definitions and some examples and illustrative pictures were included.

The data obtained through these interviews was analysed using descriptive statistics. The average values given to the different ES and land use categories were used to build a matrix that was subsequently associated to a CLC shapefile and mapped. The results of this first mapping methodology are explained in section 4.

3.5 Collaborative mapping of Ecosystem Services

The implementation of the second mapping methodology was based on a workshop with twelve participants, including nine representatives of the AB institutions, two representatives of Odemira municipality, and one of Polis Litoral Sudoeste, a regional development program based on the Alentejo and Vicentine coasts. Through this workshop, we intended to launch discussion, to gain insight on the spatial distribution of key ES and to build consensus over the regional supply of ES. Following a presentation of the results obtained through the individual interviews explained in the section 3.4, participants were asked to choose the three most relevant ES in the park from the list of 22 ES.

Table 3 - Categories included in the panel based on Corine Land Cover (CLC) legend level 3

Artificial surfaces
Non-irrigated arable lands
Permanently irrigated lands
Pastures
Heterogeneous agricultural areas
Forests
Scrub and/or herbaceous vegetation associations
Open spaces with little or no vegetation
Inland waters and wetlands
Marine waters

Whereas the first method (section 3.4), facilitated the construction of a matrix based on average values for each land use category resulting from the individual interviews, with this exercise we pursued further disaggregation through collective discussion.

In this exercise, participants worked in two groups, each of whom was given a list of five ES of the top ten ranked ES, marker pens and five blank maps of the park. As supporting information, they counted on topographic and land use maps, and definitions of all ES. We asked them to use one blank map for each ES assigned, and to draw the areas where the provision of that ES was richer. These areas were called ES hotspots, understood as “areas which provide large proportions of a particular service” (Egoh *et al*., 2008: 136). When possible, participants were to specify some illustrative examples for each polygon drawn. Additionally, each group filled a table indicating the trends experienced by the ES mapped in the last decades and the underlying causes.

In the afternoon session, the maps were all hung on a wall. A representative of each group explained the contents, whereas the other participants commented and completed the information when necessary. The trends and drivers of change, collected during the break, were also presented to the group and discussed. In subsequent stages, the collaborative maps produced during the workshop, were scanned, geo-referenced and digitized.

4. RESULTS

The several steps of this research provided very relevant data to characterize and to map the overall capacity of this coastal area to supply ES. When looking at the average rating of ES by type, the cultural services are the most highly rated by the AB members followed by regulating services, the provisioning services coming last. A ranking of the average value given to each ES (table 4), shows ‘Recreation’ and ‘Aesthetic’ ES, both cultural services linked to tourism, as the two most relevant ES supplied by the park area, followed by ‘Agriculture and livestock’, ‘Pollination, seed dispersal’ and ‘Fishing, hunting, shell fishing and aquaculture’. These results reflect the main activities existing within the park. On the bottom of this list are mostly provisioning services, such as ‘Wood fuel or plants/algae for energy use’ and ‘Minerals’.

Table 4 - AB ranking of ES capacity in SAVCNP

#	RANKING OF ES CAPACITY IN THE STUDY AREA	TYPE OF ES*	AVRG	STD DESV
1	Recreation and tourism	C	4,00	0,76
2	Aesthetic	C	4,00	0,00
3	Agriculture and livestock	P	3,67	0,52
4	Pollination, seed dispersal	R	3,60	0,55
5	Fishing, hunting, shell fishing and aquaculture	P	3,29	0,76
6	Existence	C	3,29	1,11
7	Provision of habitats for nursery and reproduction	R	3,17	0,98
8	Freshwater for domestic, agricultural or industrial use	P	3,00	1,15
9	Scientific and environmental education	C	3,00	1,21
10	Cultural heritage and traditions	C	3,00	0,76
11	Water supply and flow regulation	R	2,83	0,98
12	Global climate regulation by reduction of greenhouse gas concentrations	R	2,57	1,27
13	Gathering	P	2,43	0,53
14	Erosion prevention, and soil and coastal stabilization	R	2,43	1,27
15	Micro and regional climate regulation	R	2,43	1,40
16	Assimilation and degradation of waste and toxics (in soil, water, atmosphere) by the ecosystem	R	2,29	0,95
17	Formation and maintenance of soil fertility	R	2,17	0,75
18	Fibres and other materials	P	2,14	0,90
19	Wood fuel or plants/algae for energy use	P	2,00	0,71
20	Minerals	P	2,00	1,26
21	Water quality regulation	R	2,00	1,00
22	Renewable abiotic energy sources	P	1,00	0,00

* C – Cultural ES; P – Provisioning ES; R – Regulating ES.

Another interesting result is the degree of concordance between different stakeholders when rating the same ES, indicated in table 4 by the standard deviation values. High concordance levels are thus identified in ES such as 'Minerals', 'Aesthetic', 'Agriculture and livestock', whereas significant divergence characterizes in others such as 'Erosion prevention, and soil and coastal stabilization', 'Micro and regional climate regulation' and 'Global climate regulation by reduction of greenhouse gas concentrations'. These results may reflect a greater difficulty of stakeholders to understand regulating ES, when compared to provisioning or cultural services. These divergences also highlight the subjectivity of these methods – based on the perceptions of stakeholders with different backgrounds, activities and interests, these approaches imply significant levels of bias.

The rating of ES was also represented in relation to land cover categories existing in the park. The results in figure 2 show that 'Marine waters' are considered as the top supplier of ES, closely followed by 'Inland water and wetlands' and 'Forests'. The 'Marine waters' category was also pointed out as having potential for the provision of a considerably wider range of services currently unexplored in this area (e.g. renewable energy sources).

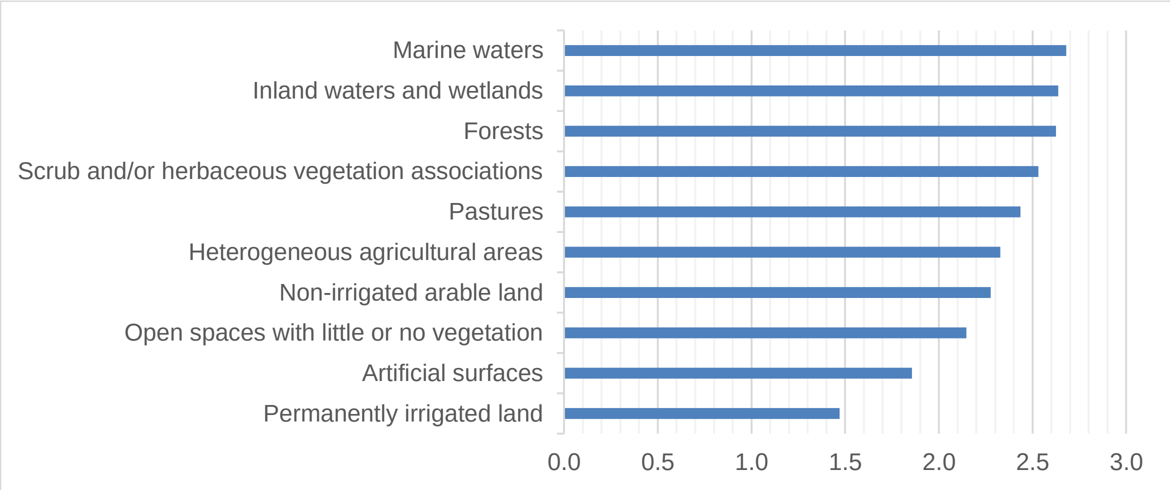

Figure 2 - Average rating of ES by land cover type

These preliminary results allowed us to develop a mapping of perceived ES based on a spreadsheet method. Three examples of the resulting maps are shown in figure 3, where these can be compared with the corresponding maps produced during the collaborative mapping exercise.

There seems to be a certain overlap in the results provided by both methodologies. Still, they produced different levels of information and detail. The maps resulting from the spreadsheet method facilitate the identification of differences between land cover categories whilst covering the total case study area. Its main gap is a certain level of generalization, as at CLC Level 3, this method is not sensitive to the diversity of subclasses and differences of land use intensity within a category. As for the collaborative mapping method, this focuses on the "hotspots" of ES supply, overcoming the generalization by land cover category provided by the previous methodology. It also supplies more detailed information on the specific characteristic of a given ES and its spatial distribution, yet it excludes areas that despite having a low capacity to supply ES, do contribute to the regional overall capacity.

Table 5 - Maps of Ecosystem services supply for three Ecosystem Services

<table>
<tr><th></th><th>Provision of habitats for nursery and reproduction</th><th>Recreation and tourism</th><th>Agriculture and livestock</th></tr>
<tr><td>Spreadsheet method</td>
<td>
</td>
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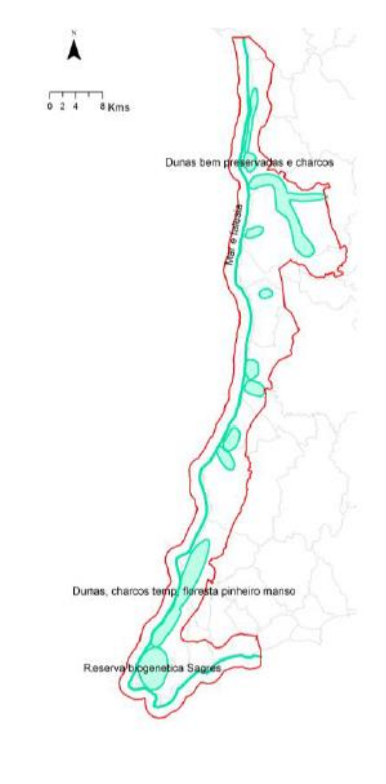
</td></tr>
<tr><td>Collaborative Mapping</td>
<td>
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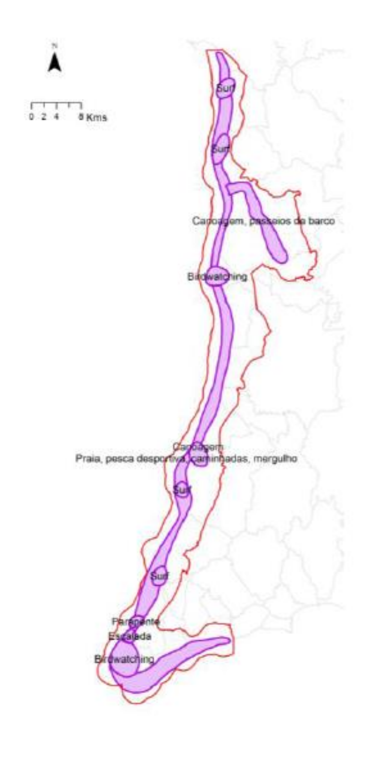
<td>
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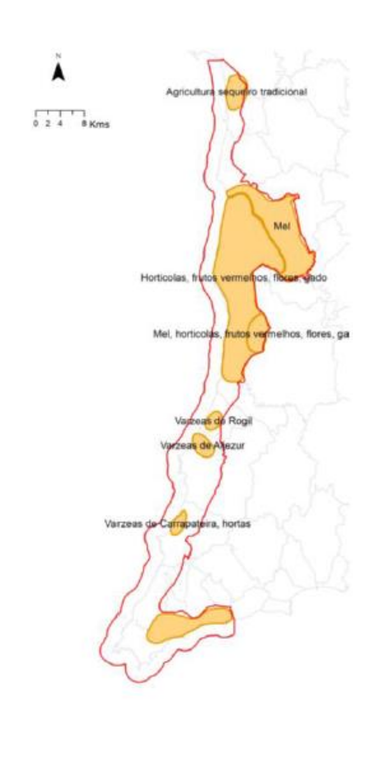
<td>
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</table>

The three maps in figure 3 show the capacity of the park's area to supply 'Provision of habitats for nursery and reproduction' (a regulating service), 'Recreation and tourism' (a cultural service) and 'Agriculture and livestock' (a provisioning service). A closer look at the maps for the 'Provision of habitats for nursery and reproduction' show, in the case of the spreadsheet method, that the whole region provides this service, whereas the collaborative mapping identifies the areas where specific habitats for this service have been identified.

The maps for 'Recreation and tourism' are consistent in highlighting the relevance of the coastline and the sea. The representations of 'Agriculture and livestock' are those presenting fewer differences. This can be explained by the use of the same proxy indicator (crop areas) in both methods.

5. DISCUSSION AND CONCLUSION

In the previous sections, two methodologies for the mapping of Ecosystem Services supplied by the case study area were tested and compared. We found some advantages and disadvantages in both methodologies that are summarized in Table 5.

The methodology based on a spreadsheet correlating ES and land use categories, proposed by Burkhard *et al.* (2009), showed some limitations that had already been acknowledged by Burkhard and colleagues and pointed out by other scientists. First, this approach is based on Corine Land Cover level 3, characterized by a low level of spatial definition. Indeed, the use of land use as a proxy for ES supply has been criticized for its lack of accuracy (Biest *et al*., 2015). On the contrary, this method has the advantage of providing an easy and quick mapping of large areas. Additionally, land use is an essential element of spatial planning, thus the introduction of land use in ES assessment potentially fosters the integration of ES into landscape management (Palomo *et al*., 2014).

Second, evaluations by stakeholders are subjective, being influenced by personal profiles (Burkhard *et al.*, 2009). Martínez-Harms and Balvanera (2012) add to the subjectivity of experts-based methodologies, the disadvantage of not supplying quantitative data. On a positive note, expert-based methods can provide a quick assessment (Martínez-Harms and Balvanera, 2012). In the context of our research, the use of perceptions allowed us to explore simultaneously a very comprehensive set of ES, whilst potentially promoting social learning through the engagement of stakeholders. In any case, as recommended by Burkhard *et al.* (2009), this methodology is to be understood as research hypotheses that need to be proved, contrasted against and complemented with monitoring data, models, statistics, etc.

Turning to the collaborative mapping methodology, it shares the advantages and disadvantages referred for the expert-based approaches. Despite the deficient spatial accuracy of the maps produced during the collaborative mapping exercise, this proved extremely helpful to obtain a large amount of contextualized information on key ES in the area, their trends and threats. Much of this information was possible through the interaction of participants with different areas of expertise. Participatory mapping has been reported as being useful to raise awareness, whilst enhancing empowerment and the introduction of local knowledge in management decision-making (Palomo *et al*., 2014). Moreover, stakeholders' engagement facilitates the introduction of perceptions that result from a regular interaction with the territory, as well as insights on the human-environment relationship (García-Nieto *et al.*, 2014). Last and very importantly, the involvement of local stakeholders is considered as a strategy to reduce conflict.

Table 5 – Summary of the advantages and disadvantages of both methods.

	Advantages	**Disadvantages**
Spreadsheet method	• Fast to execute • Easily replicable • User friendly	• Relies on the availability of land cover data • Poor detail at the local level • Subjective
Collaborative mapping	• Provides more detailed information on the ES • Data is more updated • Increases stakeholders knowledge and awareness	• Time consuming • Costly • Subjective

Concluding the previous paragraphs, despite a great potential in both methodologies presented, none of them should be used alone. This is particularly relevant considering that the two approaches are based on social perceptions. Instead, we propose to use them complementarily. The results of their implementation to the case study area reflects the value of its complementarity – whereas the spreadsheet approach provided a quick spatial representation of ES supply associated to the main land cover typologies covering the park area, the collaborative mapping exercise brought additional data on spots of special value for the provision of ES, their trends and threats affecting them. This combination of approaches appears as a potential strategy to overcome an important limitation of methods based on land cover data (e.g. CLC) when used in coastal areas. This regards the detail provided for land cover categories, which is considerably more developed for inland than for coastal classes. Consequently, collaborative mapping can bring additional data to classes insufficiently detailed in CLC.

The methodologies introduced in this paper show some additional advantages for their use in the planning and management of protected coastal and marine areas. It is important to highlight that these figures are more recent than inland protected areas, and that less data and experience is available for their planning and management. The ES supplied by coastal and marine ecosystems have not yet been much explored, and yet the use of approaches based on ES assessment, can become useful tools in support of their preservation by highlighting the value of these habitats as producers of very rich ES. This richness was reflected by stakeholders' views in the exercise based on the spreadsheet method, where the class 'Marine waters' obtained the greatest average valuation. Similarly, the coastal line was considered a hotspot in two of the three collaborative maps represented in Figure 3.

As a concluding remark, the use of the methodologies presented in this paper can become a very valuable tool to support decision making, planning and management in coastal and marine protected areas. But as above referred, participatory methodologies have important weaknesses, such as the subjectivity and the qualitative nature of data produced. For this reason, it will be important to complement participatory with more objective and scientific data, such as biophysical and socioeconomic indicators.

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