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RESEARCH

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## The role of private landowners for generating cultural ecosystem services in Mediterranean rural landscapes: a case study in Andalusia (Spain)

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### ABSTRACT

More than 60% of the European population lives in areas considered rural. In many cases, this rural population has been consolidating cultural landscapes regarded as socio-ecological systems preserving traditional agrarian practices and biocultural diversity. These landscapes are threatened by land intensification and rural abandonment, thus decreasing the supply of cultural ecosystem services (CES). In this context, it is important to study the current and potential activities of landowners to generate CES. With this objective, a Spanish rural area was analysed, based on 55 surveys with landowners on the territory's general characteristics and their current and potential activities that should be promoted to increase the contribution of CES. The results showed four distinct clusters, which could be representative of the farms in the area studied. Two of them distinguished by a high presence of natural vegetation without livestock and the remaining two by a low presence of natural vegetation and livestock. In all four clusters, landowners are aware of the importance of generating CES related to the sense of belonging to the region and recreational hunting. Finally, actions by landowners, the role of public institutions and different strategies have been presented to conserve and implement CES-generating activities. This research constitutes a basic study aimed at ascertaining the current and potential CES, the awareness of the generators of these services and the support options of public institutions to promote traditional rural areas facilitating their revaluation, using multi-scale policies (European, national, and regional) to encourage their maintenance and that of their CES.

### KEY POLICY HIGHLIGHTS

- In the Andalusian cultural landscapes, the main groups of landowners were characterized according to their activities that generate cultural ecosystem services. The main activities identified, current and potential, are related to the sense of belonging to the region (that is an identification of landowners with their environment and their activity) and recreational hunting.
- Among the practices to conserve current and potential CES generating activities, control of invasive species, management of the territory that functions as habitat for different species, road infrastructure and waste management were considered. Regarding the importance of public institutions, direct or indirect financial support was highlighted as practically the most relevant measure for all landowners.
- Our results showed the importance of taking into account the needs and demands of private landowners when establishing planning and management policies in rural areas for the sustainability of traditional multifunctional (multiservice) social-ecological landscapes. Their sustainability contributes to the Sustainable Development Goals (SDGs) 3, 11, 12, 13 and 15.
- The policies to be applied, in these rural cultural landscapes, should have a flexible framework for action that would consider the local social-ecological context. Taking into account the typology of landowners three policy actions are proposed: stimulation, facilitation and innovation.

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## 1. Introduction

Rural landscapes in Europe have a millenary character, being closely related to agricultural, forestry and livestock activities (Arriaza et al. 2004; González-

Ávila et al. 2020). Currently, 66% of Europe's population lives in rural areas (Agnoletti et al. 2019). In fact, almost all European rural areas have been transformed or modified over time by humans and can

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be considered as the result of the evolution from a landscape without human activity to a cultural landscape (Aplin 2007). Several authors such as Rendon et al. (2019) or Picuno et al. (2019) argue how the term cultural expresses human interaction with the environment and the presence of tangible and intangible cultural values in the landscape. Thus, cultural landscapes represent a natural and cultural heritage of high interest from a conservation point of view. Cultural landscapes are the historical result of the union of land use and management, agricultural policies and the characteristics of the people who work and manage the landscape (Rescia et al. 2010; Maldonado et al. 2018). Typically, the spatial and functional configuration of such landscapes result from centuries of interaction between nature and humans, and therefore reflect the mutual adaptation of natural biotic and abiotic factors, with these landscapes being considered as complex adaptive socio-ecological systems (Proulx 2007; Rescia et al. 2012). These landscapes are rarely uniform, frequently evidencing a mosaic with different degrees of ecological maturity from a successional point of view, where agriculture is a fundamental component (Fuller et al. 2017; Rodríguez Sousa et al. 2020, 2023). These heterogeneous landscapes are characterized by the conservation of traditional practices (e.g. extensive mountain livestock farming, rainfed olive groves, agroforestry landscapes) and biocultural diversity (e.g. ancestral agricultural varieties external to commercial circuits), being fundamental in the promotion of rural development and nature conservation (Agnoletti et al. 2019).

In relation to cultural landscapes and from disciplines that focus on the social dimension, there are precedents that define the landscape under aesthetic and moral values, which concerns the scope of the identities of the communities that inhabit it (Thiébaud 2011). There are also studies that approach it as the expression of processes that combine natural and cultural elements, focusing in most cases on two axes: the valuations that the inhabitants make of the transformed landscape under socio-economic and historical phenomena (Thiébaud 2011; Dorning et al. 2017; Sales 2020) and the physical transformations associated with land cover losses and changes in use (Rescia and Ortega 2018). However, there is missing academic literature focused on investigating the cultural ecosystem services (CES) generated in landscapes built by private rural landowners.

Regarding the contribution of ecosystem services (ES) from these landscapes, in addition to provisioning and regulating ES, which can vary greatly depending on the specific system, the contribution of CES stands out. CES refers to the non-material benefits that society derives from nature, which contribute to maintaining the current state of population well-

being (Millennium Ecosystem Assessment MEA 2005). Within the classification of CES, there are several categories among which it is necessary to highlight those services linked to a) recreation and health; b) aesthetic values and environmental education; c) recreational hunting; d) sense of belonging; e) cultural heritage; f) rural tourism, research and scientific development; and g) traditional or local ecological knowledge (Pleasant et al. 2014; Kosanic and Petzold 2020).

In the Mediterranean basin, many of the cultural landscapes are multifunctional and their economic, social and environmental dimensions are quite balanced. However, these systems are threatened by two opposing trends of land use and management change, consisting of agrarian intensification and rural abandonment (Schmitz et al. 2003). The former leads to the dominance of large-scale monocultures and the stabling of livestock, generating systems of greater landscape simplicity where the diversity of ES contribution is reduced, and biodiversity is also decreasing due to the increased use of chemical fertilizers and pesticides (Assandri et al. 2018; Bidegain et al. 2020). On the other hand, rural abandonment, derived from the low economic profitability of the primary sector, shows multiple social impacts, involving emigration, population aging and loss of cultural heritage (García-Ruiz et al. 2020), as well as environmental effects, leading to a greater scrubbing of the environment, which can increase the risk of fires (Farina 2000).

Authors such as van Berkel and Verburg (2014) point out that, although landscape transformations affect CES, these can be preserved and strengthened so as to cope with socio-economic pressure in rural areas. In this sense, the recognition of the importance of ES by rural producers is usually very favourable, especially in systems linked to protected areas, tourist facilities or rural residences, and there is a strong social predisposition towards the conservation and promotion of these practices (Egoh et al. 2007). Rural communities show commitment towards CES conservation and implementation in the areas they inhabit, and, in the study area, there is a trend towards diversification of rural economic activities, which constitute a secondary source of economic income for landowners and workers in the primary sector, in addition to the income directly related to agricultural or livestock activities (Campón-Cerro et al. 2017). This diversification, in addition to enhancing alternative income possibilities to rural uses *per se*, opens a wide spectrum of new CES that can be provided by rural landscapes, specifically by farmers in rural areas. With this in mind, the objective of this research is to analyse current and potential activities that generate CES from the perspective of rural private landowners in order to propose management

strategies aimed at fostering these activities, thus contributing to the promotion and preservation of CES in specific rural contexts. Specifically, we characterised landowners according to their activities and their farms according to land use and land cover (a), assessed CES generated and those to be promoted and economic support policies (b) and the perception of landowners regarding their CES-generating activities and the support received (c). In addition, the importance of both landowners and their farms for the provision of CES, conservation of the socio-ecological landscapes and their contribution to certain SDGs were discussed.

## 2. Methodology

### 2.1. Study area

The *Montes Orientales* region, in Granada (Andalusia, Spain), was selected as the study area (Figure 1). This region is made up of 19 municipalities, 12 of which have been considered for this research, (those with the strongest links to the rural environment). This region, which belongs to the *Guadalquivir* River basin, has an area of more than 123,000 ha (Martín et al. 2011). In this region, where the *Sierra Arana* mountain is located, the altitude ranges from 1,200 to 2,030 m above sea level (masl), with a predominantly dry-sub-humid continental Mediterranean climate. It has average temperatures between 11.5°C and 16.0°C, periods of summer with water stress (i.e. June-August), and an average annual rainfall of 400 mm. The area has predominantly limestone soils and sclerophyllous vegetation such as holm oaks (*Quercus ilex*, L. 1753) or Aleppo pines (*Pinus halepensis*, Mill.

1768) which are usually found together with flowering aromatic plants such as rosemary (*Rosmarinus officinalis*, (L.) Schleid 1852), thyme (*Thymus* sp., L. 1753), and lavender (*Lavandula* sp., L. 1753) (Casco et al. 2018). All these species are part of the so-called Mediterranean holm oak forest and the Aleppo pine forms typical pine forests of the Mediterranean area and are the typical vegetation present in the less transformed farms of the study area. There is also a great diversity of ethnobotanical flora, vertebrates (e.g. mammals and birds), and invertebrates (i.e. arthropods) (Benítez et al. 2016).

### 2.2. Preliminary identification of activities that generate CES

From a socio-economic and main-land-use point of view, the economic activity of this region revolves around the primary sector (i.e. agriculture and livestock), presenting more than 90,000 ha of agricultural uses that represent more than 12% of the agricultural holdings in Granada (Ruiz-Frau et al. 2009; Casco et al. 2018). The crops can be herbaceous (24.1% of the area), predominantly cereal, or woody crops (43.6% of the area), highlighting the existence of olive or almond monocultures (Rodríguez Sousa et al. 2020). In addition to agricultural land uses, the region is famous for its hunting resources.

The main activities that generate CES in the study area were identified in Table 1, based on literature review (Milcu et al. 2013), previous studies conducted in this region (García-Llorente et al. 2012; Iniesta-Arandia et al. 2014) and surveys

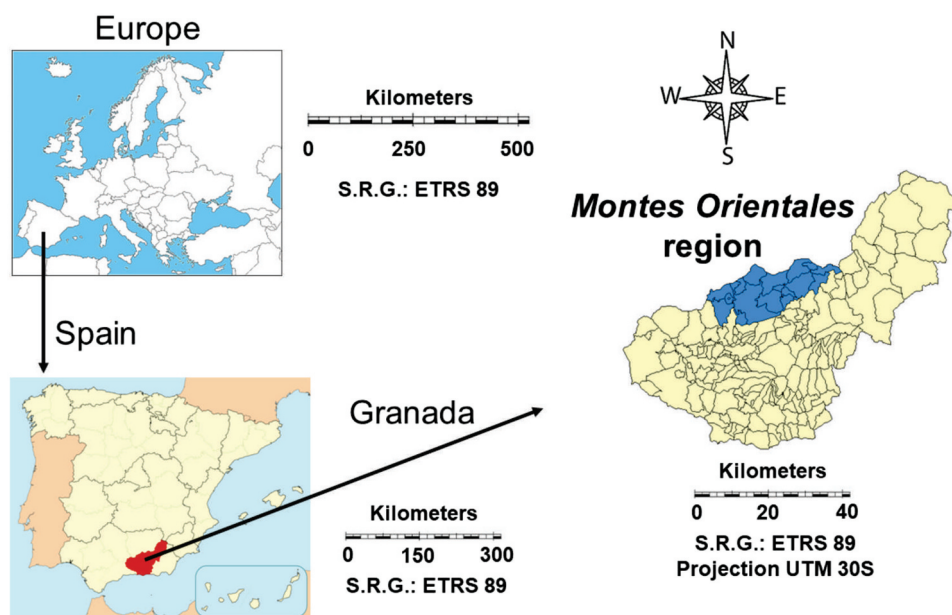


Figure 1. Geographic location of the study area.

**Table 1.** Main activities generating CES.

Activity	Cultural ecosystem services
– To know that species of interest exist/are preserved and to be able to visit them	– Valuing the existence of biodiversity
– To contemplate, enjoy landscapes with water, snow, mountains, natural vegetation, etc	– Tranquillity, relaxation, peace
– Traditional agricultural infrastructures, in particular water collection, distribution and use such as terraces, waterwheels, irrigation ditches, practice as mountain grazing, traditional cultivation	– Traditional knowledge of the territorial system/ Local ecological knowledge
– Workshops on agricultural maintenance, cultural traditions, conservation of species	– Environmental education
– Research carried out in the area. Scientific dissemination	– Scientific knowledge
– Hiking, horse riding, mountain activities, gastronomy, recreational activities	– Rural/nature tourism
– Small game hunting (e.g. rabbit, partridge)	– Recreational hunting
– Sense of belonging to the region	– Local identity/Sense of place

through informal conversations with local inhabitants.

### 2.3. Survey and sample design to identify current and potential CES generating activities

Taking into account data from existing socio-economic, environmental and population databases in the study area<sup>12</sup> the landscape of 120 rural properties (10 for municipality) have been visited. Landowners showed their availability to collaborate in the study. All the rural properties and landowners show the environmental and socio-economic variability of the study area. Then, 68 participants were selected on the basis of simple random sampling reflecting this variability. Only 55 were valid, designed and applied, therefore, to a total of  $n = 55$  individuals. All participants were informed about the research objectives. All participants gave their consent to participate in the study and their consent to publish the results. The surveys were aimed at rural landowners (i.e. farm owners who, in some cases, carry out productive activities that are not linked to the study area, e.g. teaching).

The questionnaires of said surveys were tested and adapted in consultation with experts. They were conducted face-to-face over a period of six months (between July and December 2020), in the 12 municipalities selected. The questions were organised in three sections (see Annex 1) Section 1: Social information about landowners and general characteristics of the study area; Section 2: CES-generating activities taking place in the study area or that could potentially be promoted, (response format: a Likert scale, rating from 1 to 5, with 1 being the minimum and 5 the maximum, (Joshi et al. 2015)); and Section 3: Actions by private landowners to sustain CES-generating activities, (response format: Yes = 1; No = 0).

### 2.4. Statistical analyses

In order to determine the parametric or nonparametric nature of the data, a Kolmogorov-Smirnov-Lilliefors and Levene test was performed to evaluate its normality and homoscedasticity (Parra-Frutos 2016). Subsequently, a hierarchical clustering analysis

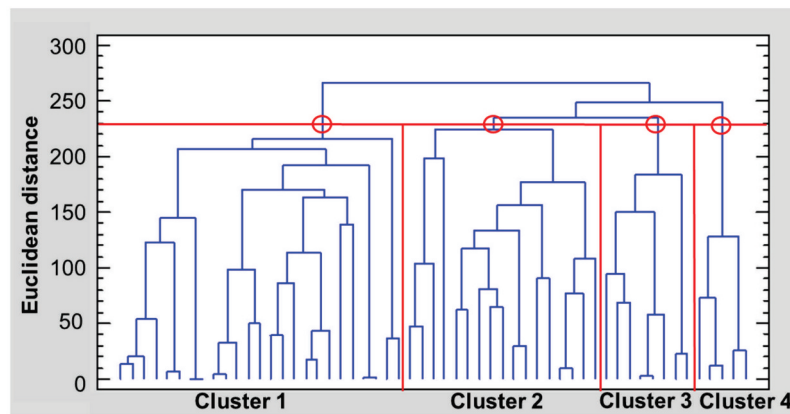
was performed with the aim of finding similarities and differences between clusters or groups of respondents, generating an agglomerative dendrogram where observations start out independent and are grouped by statistical similarity (Govender and Sivakumar 2020). All variables from survey Sections 1 and 2 were introduced in the analysis. Ward's method (i.e. minimum variance method) and the Euclidean distance were used as criteria for the generation of homogeneous clusters. From those clusters generated, the possible existence of significant differences between them was tested through the implementation of a median comparison test (Sawilowsky and Fahoome 2014), identifying such differences through a Tamhane post-hoc test (Elliott and Hynan 2011). Finally, a descriptive analysis of the data obtained for each cluster was carried out based on respondents' answers, thus shedding light on the population profiles, the main land uses of the territory, and characterizing the perceptions about activities that generate CES. All analyses performed were executed employing Statgraphics Centurion XVIII ® software (Statgraphics 2020), using a significance level of  $\alpha = 0.05$  (Sales et al. 2023).

## 3. Results

### 3.1. Characterization of farms and landowners

The results obtained for the variables implemented in the surveys showed a non-normal and heteroscedastic character, attaining highly significant p-values ( $p < 0.001^{***}$ ) in the Kolmogorov-Smirnov-Lilliefors and Levene tests. From the multivariate hierarchical analysis, four different clusters were identified (Figure 2).

These clusters show the segregation among respondents in relation to different aspects described in Table 2: landowners' profiles, the characteristics and size of their farms, their activities and the main land uses and land cover of farms. In general, clusters 1 and 3 have the highest presence of Mediterranean forest and scrubland, only clusters 2 and 4 have livestock use, cluster 3 has no watercourses and only clusters 1 and 2 have renewable energy infrastructures. In 3 clusters fewer than 50% of the landowners had agricultural activities (e.g. herbaceous – barley and oats – and woody crops – olive groves –



**Figure 2.** Dendrogram showing cluster classification of respondents. Red lines and circles indicate nodes and cluster generation.

**Table 2.** Characterization of landowners and their main source of income and description of land use and land cover of the farms. Primary activities refer to agriculture, both arable crops (predominantly barley and oats) and woody crops (predominantly olive groves). Secondary activities refer to trades linked to construction or industry (workers, electricians, engineers) and tertiary activities to the service sector (teachers, health).

	CLUSTER 1	CLUSTER 2	CLUSTER 3	CLUSTER 4
Landowners' size of farms, profile and main economic income by primary sector activities	<ul style="list-style-type: none"> <li>– Average property size: 28.30 ha</li> <li>– Number of individuals: 25</li> <li>– Average age: 58.20 years</li> <li>– 72% male and 28% female</li> <li>– 40% primary activity</li> <li>– 60% secondary activity (various tertiary sector professions)</li> </ul>	<ul style="list-style-type: none"> <li>– Average property size: 55.59 ha</li> <li>– Number of individuals: 17</li> <li>– Average age: 48.24 years</li> <li>– 64.70% male and 35.30% female</li> <li>– 58.82% primary activity</li> <li>– 41.18% secondary activity (various tertiary sector professions)</li> </ul>	<ul style="list-style-type: none"> <li>– Average property size: 38.13 ha</li> <li>– Number of individuals: 8</li> <li>– Average age: 64.13 years</li> <li>– 37.5 male and 62.5% female</li> <li>– 25% primary activity</li> <li>– 75% secondary activity (various tertiary sector professions)</li> </ul>	<ul style="list-style-type: none"> <li>– Average property size: 35 ha</li> <li>– Number of individuals: 5</li> <li>– Average age: 63 years</li> <li>– 20% male and 80% female</li> <li>– 20% primary activity</li> <li>– 80% secondary activity (various tertiary sector professions)</li> </ul>
Percentage of farms with different land uses and land covers	<ul style="list-style-type: none"> <li>– Access roads and little residential area</li> <li>– Agricultural use: 90% with extensive cereal crops, olive groves (200 trees/ha) and almond trees and 10% with intensive leguminous crops and olive groves (600–800 trees/ha)</li> <li>– 65% with Mediterranean holm oak forest (<i>Quercus ilex</i>, L. 1753) and 70% with sclerophyllous scrub vegetation.</li> <li>– 70% with watercourses</li> <li>– 8% with solar panels or wind turbines</li> </ul>	<ul style="list-style-type: none"> <li>– Access roads and little residential area</li> <li>– Agricultural use: 90% with extensive cereal, olive and almond crops, 12% with livestock use, 10% with intensive asparagus and olive crops</li> <li>– Under 20% with presence of Mediterranean holm oak forest and between 20–40% hedgerow and scrub vegetation</li> <li>– 35% with watercourses</li> <li>– 6% with solar panels or wind turbines</li> </ul>	<ul style="list-style-type: none"> <li>– Access roads in very good condition and little residential area</li> <li>– Agricultural use: 100% with extensive cereals and olives crops. No intensive crops</li> <li>– More than 60% with presence of Mediterranean holm oak forest and fewer than 20% with watercourses</li> <li>– More than 70% scrub vegetation</li> <li>– No solar panels or wind turbines</li> </ul>	<ul style="list-style-type: none"> <li>– Access roads with no residential area</li> <li>– Agricultural use: 100% with extensive cereals, leguminous plants, sunflower and olive crops and 20% with livestock use (sheep and goats)</li> <li>– 40% with Mediterranean holm oak forest and 40% with scrub vegetation</li> <li>– 80% with grazing land</li> <li>– No watercourses</li> <li>– No solar panels or wind turbines</li> </ul>

livestock) as their main economic income. Clusters 1, 3 and 4 have smaller farm sizes and a higher average age than cluster 2. In turn, clusters 1 and 2 have a markedly male-dominated gender profile, in contrast to clusters 3 and 4.

Table 2 shows that the farms studied consisted of heterogeneous rural landscapes, with a predominance of extensive agriculture. Particularly, on most of the farms in cluster 1 and cluster 3 there is a Mediterranean holm oak forest, together with scrublands and extensive olive groves and watercourses, that is a heterogeneous landscape. However, cluster 4, with less spatial

heterogeneity and without watercourses but with grazing activity. Even though the main activity of the farms studied is extensive agriculture, in clusters 1 and 2 the presence of wind turbines and photovoltaic panels for renewable energy generation stood out and cluster 2, with livestock use, was more intensely highlighted for potential CES-generating activities than for current ones. Essentially, there was a trend of increasing service-generating activities in less heterogeneous rural landscapes, such as cluster 2 and 4, but especially the former. This is probably due to the fact that this is characterized by the larger average farm size

and younger landowners whose prevalent main income derives from farm activity (see also Figure 4).

### 3.2. Current activities that generate CES and those to be promoted

From the 4 clusters identified, Figure 3 shows the similarities and the significant differences between the clusters in relation to the existing activities in the study area on the generation of CES (Figure 3a), as well as the existence of differences in relation to the degree of importance given to activities generating cultural services that could potentially be promoted if landowners received additional economic incentives (Figure 3b).

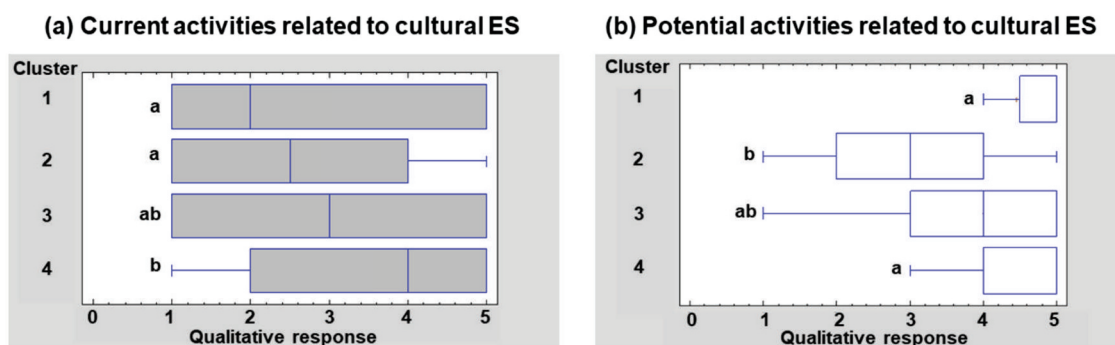
According to the answers of the landowners corresponding to clusters 1 and 2 on the contribution of current CES generating activities in the study area, they could be grouped into a homogeneous group, which considered these contributions to be relatively low (average values of appreciation below 3). While cluster 3 evidenced an intermediate behaviour, not statistically differentiated from any other cluster by dominating an average perception of the contribution of the activities, cluster 4 was identified as a statistically different one, with average ratings towards these activities of 4 out of 5 (high appreciation of current CES contribution).

In Figure 3b, related to activities potentially generating CES, the landowners corresponding to clusters 1 and 4 did not show significantly different perceptions, valuing the (economic) promotion of this type of activities as very positive. On the other hand, cluster 2 did show significant differences, valuing to a lesser extent (i.e. mean value of 3 out of 5) the importance of promoting the activities that generate CES. Finally, cluster 3 showed partial similarities with the rest of the clusters, showing higher scores than cluster 2, but less than clusters 1 and 4.

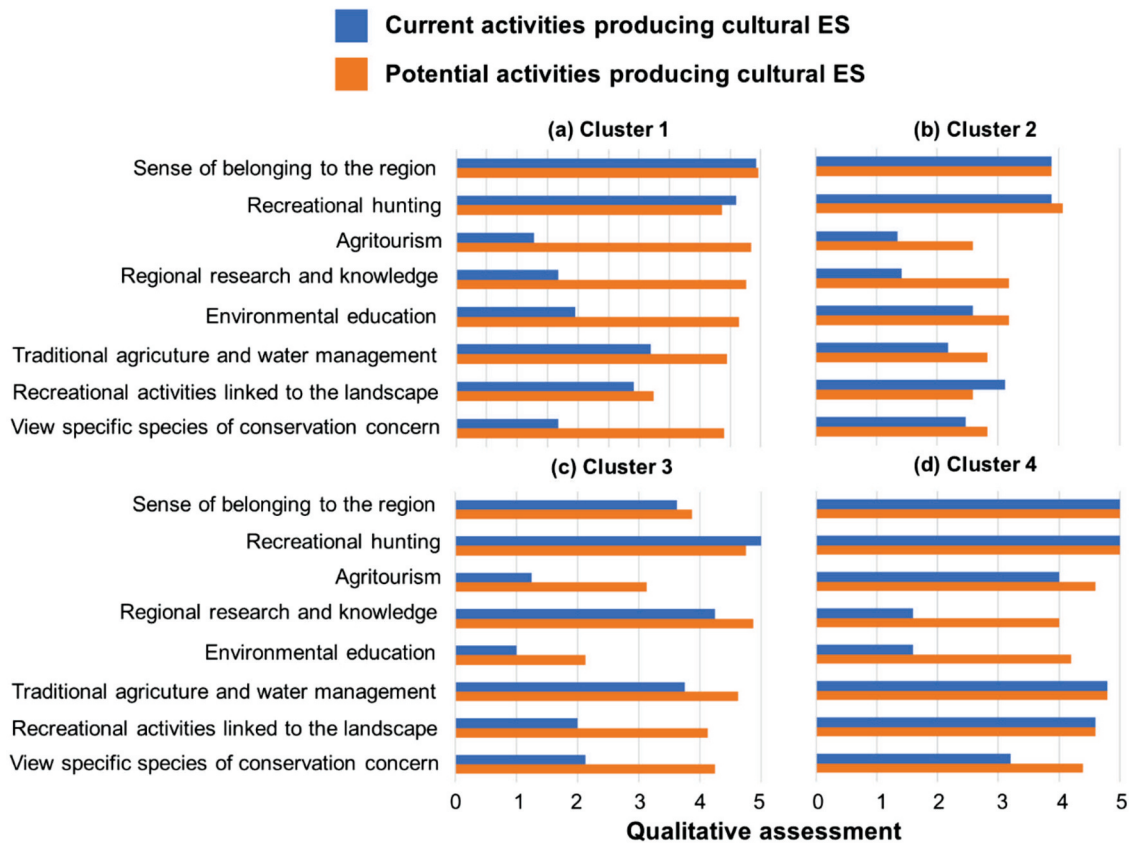
Figure 4 synthesizes the average valuations of the landowners towards the CES generating activities (current and potential). Looking at Figure 4a, it can be seen that cluster 1 identified the importance of activities that generate CES related to the sense of belonging to the region, recreational (small game) hunting and traditional agriculture and water management (i.e. average values above 3 out of 5). With respect to the potential activities valued as the most important to subsidize with the aim of maintaining or increase the flow of this type of ES, those related to agritourism (or rural/nature tourism), regional research and scientific knowledge and environmental education were considered (i.e. values higher than 4). The landowners believe that their territory offers, to a lesser extent, recreational activities related to landscape such as hiking, horse riding, mountain activities, gastronomy, possibilities for scientific research, the presence of species (animals -birds, insects- or plants) that motivate people to visit them or environmental education (maintenance of agriculture, conservation of species).

Cluster 2 (see, Figure 4b) was characterized by a higher rating (over 3) of activities related to the sense of belonging to the region and small game hunting, coinciding with cluster 1. Likewise, they indicated contemplating and enjoying landscapes with water, snow, mountains, natural vegetation as one of the most predominant. However, in this case, the potential activities considered most important for improving the flow of these ES coincided with the current activities already mentioned, but also highlighting regional research and knowledge and environmental education (i.e. ratings higher than 3)

Figure 4c shows that cluster 3 was characterized by valuing more highly current activities such as recreational hunting (i.e. with a maximum qualitative score), research and scientific knowledge, traditional management as well as the sense of belonging to the region (as in previous clusters). As for the valuation



**Figure 3.** Mean results and standard deviation (i.e. boxplots) obtained for each cluster of landowners with respect to the degree of perception of current activities generating CES (a) and potential activities generating such services (b). A value of 1 corresponds to no contribution and a value of 5 to very high contribution. The letters located in each cluster indicate the generation of homogeneous clusters based on the Tamhane post-hoc test implemented.



**Figure 4.** Current and potential activities generating CES. The values are expressed as the mean value per activity in each cluster from 0, not at all, to 5, very important, according to the valuation of the landowners.

of potential activities, all the proposed activities, except for environmental education, were valued with scores above 3.

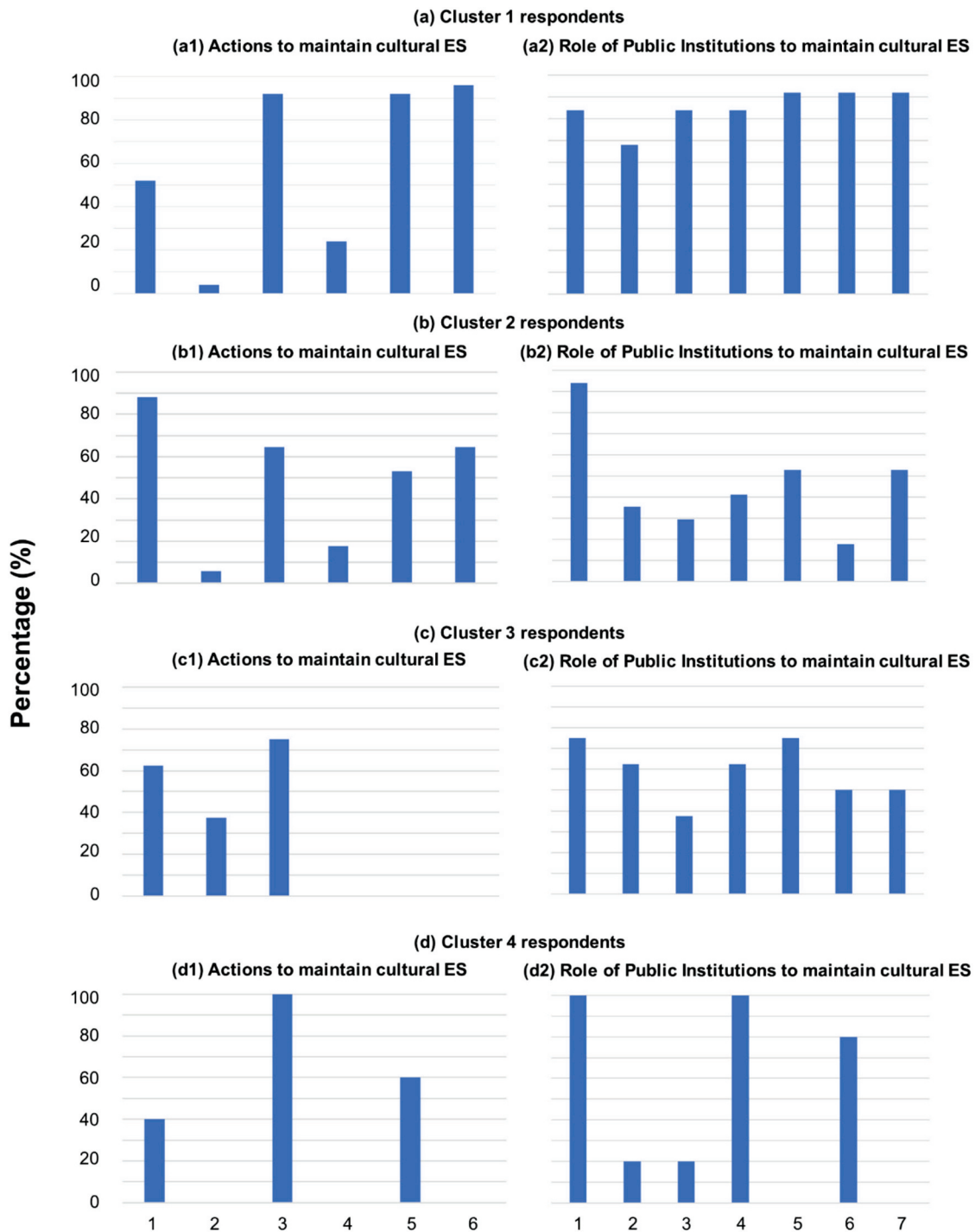
Cluster 4 (see, Figure 4d) was dominated, as in previous clusters but in a more accentuated way, by a very positive valuation of sense of belonging to the region, small game hunting, traditional agricultural management and recreational activities linked to landscape (hiking, horse riding, mountain activities, gastronomy, with scores above 4). Regarding the potential activities valued, similarly to cluster 3, all the proposed activities obtained scores higher than 3, with special relevance for sense of belonging to the region, small game hunting, traditional agricultural and water management (particularly the system of water collection, distribution and use), contemplating and enjoying landscapes with water, snow, mountains, natural vegetation, research carried out in the area and scientific dissemination and workshops on agricultural maintenance, traditions, and conservation of species (i.e. scores higher than 4).

### 3.3. Practices to conserve and optimize the generation of CES and possible public policies to support them

Regarding the activities identified as CES generators both in the present and in their future potential,

landowners carry out several practices with the aim of preserving and optimizing them. Among the options mentioned are practices related to accessibility, waste management, environmental education, management of invasive and pest's species and natural habitats, together with adaptation to rural space management techniques to their regional characteristics (Figure 5a1, b1, c1, d1). In these figures, the numbers on the abscissa axes stand for: 1) Maintenance of roads and trails as access routes; 2) Additional garbage deposits; 3) Control of invasive species and pests; 4) Outdoor learning programs; 5) Adaptation of rural space management techniques to regional characteristics; and 6) Implementation of natural habitat management practices.

Regarding the importance of public institutions actively participating in the conservation and promotion of activities that generate CES, Figures 5 a2, b2, c2 and d2 show that direct or indirect financial support was highlighted as, practically, the most relevant measure for all landowners. In these figures, the numbers on the abscissa axes stand for: 1) Direct or indirect economic support; 2) Change in planning and management rules; 3) Support for education and social training; 4) Increase in the simplicity of administrative and bureaucratic procedures; 5) Increase in public awareness and support for all services offered by ecosystems; 6) Political support and



**Figure 5.** Main activities, in percentage, implemented by the landowners in each cluster (a: cluster 1; b: cluster 2; c: cluster 3; and d: cluster 4) to maintain the CES contribution of the study area (Figure a1, b1, c1 and d1). See the text for explanation of the abscissa axis numbers in Figure a1, b1, c1 and d1. Assessment, in percentages as mentioned by the landowners in each cluster, of which measures are considered most relevant for promotion and implementation by public authorities in order to maintain the supply of CES (Figure a2, b2, c2 and d2). See the text for explanation of the abscissa axis numbers in Figure a2, b2, c2 and d2.

public recognition; and 7) Support for the creation and implementation of facilities linked to rural development. Particularly, in the case of the cluster 1, the support of public institutions and general recognition of their role as CES generators was considered to be of high relevance. Specifically, this cluster is characterized by its sensitivity to economic, political, and societal support. In the case of cluster 2, it showed lower mean weights for the importance of institutions

in preserving and fostering CES-generating activities. However, direct, or indirect economic/financial support was highlighted as the most relevant measure, with more than 90% of respondents mentioning it. Cluster 3 presented intermediate values, highlighting the importance of direct or indirect financial support by the State and the increase of public awareness and sensitisation, with ratings above 70%. In contrast, the least relevant variable was support for environmental

education or training, with a percentage of mentions below 40%. Finally, individuals belonging to cluster 4 considered State financial support, better management of administrative processes, as well as political support and public recognition (rated by 80% of respondents) to be crucial. For this cluster, the increase in public awareness and support for all services offered by ecosystems and the support for the creation and implementation of facilities linked to rural development were not mentioned.

### 3.4. Perception of landowners on conservation and future implementation of CES-generating activities and their demand for institutional support

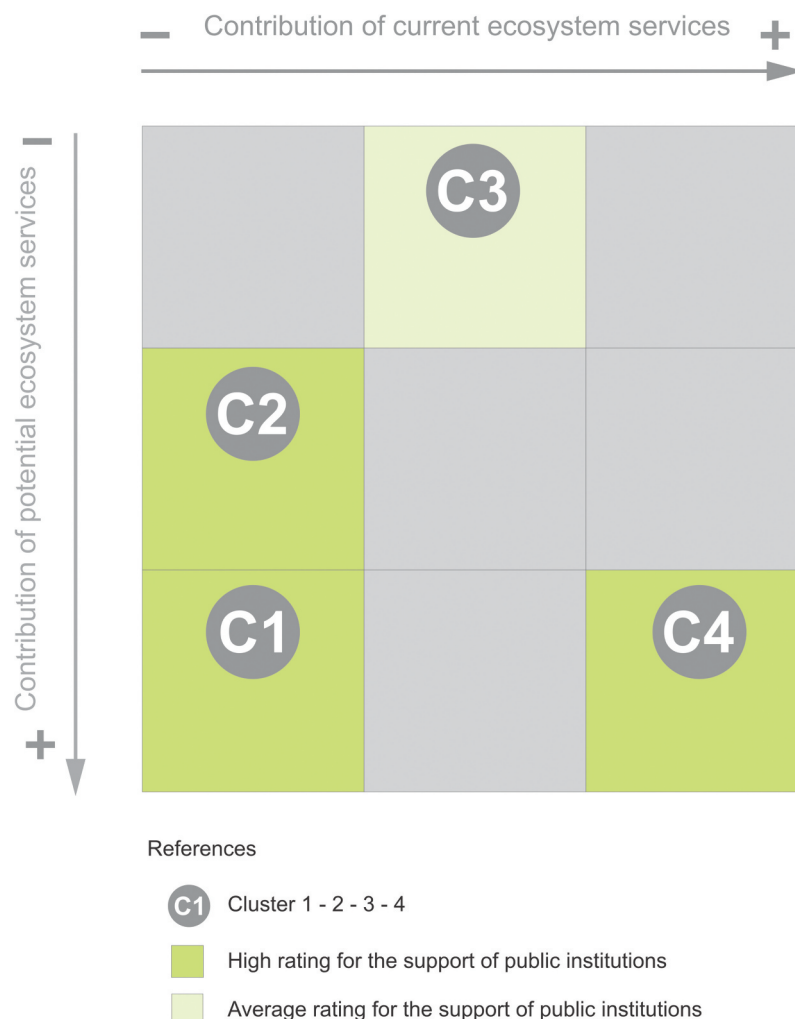
Figure 6 shows that cluster 1, although currently offering a low CES contribution, could potentially make more CES available than clusters 2 and 3. In addition, this cluster together with clusters 2 and 4 highly value the support of public institutions for the activities they could and do carry out to contribute to the generation of CES. Cluster 3 presents an intermediate current and potential contribution to

generate CES according to the perception of the landowners. This lack of perception of a high potential for the future may be due to the old age in average of the landowners and the fact that only 25% of them have farm activities as their main economic income. Finally, cluster 4 represents the most forward-looking group of landowners as they currently contribute the most to generating CESs and show the best potential for future generations. They encompass agricultural and livestock use, have not yet exploited the possibility of renewable energy infrastructures. In this case, their old age in average and the fact that most of them do not live on primary activities, has an impact on a clearer vision of the CES generated and potential ones. This cluster also showed a high demand for support from public institutions.

## 4. Discussion

### 4.1. Relevance of landowners in the preservation and promotion of CES generating activities

The socio-economic dynamics in the *Montes Orientales* region follow the pattern characteristic of



**Figure 6.** Perception of the current and potential contribution of CES combined with the demand of support from public institutions for the different cluster of landowners.

European inland mountain areas, where the economy is affected by the ageing and emigration of the local population. Within the clusters of respondents, there is a differentiation in the activities generating cultural services in relation to age. Despite the diversity of opinions within each cluster on the recognition of CES-generating activities, it can be stated that the majority of respondents in clusters 1, 3 and 4 show a higher awareness of these activities compared to respondents in clusters 1 and 2, who have a lower average age (Conway et al. 2018). In this context, it is considered appropriate to further explore the perception of CES through an intergenerational analysis as it is possible to obtain different results depending on the age cluster to which the respondents belong (Sales et al. 2023). Continuing with the profile of farmers, one of the explanatory variables of the segmentation between the clusters obtained turned out to be the gender differentiation of the respondents. It was observed that the female sector (mostly represented by cluster 4, and even by cluster 3, although it did not show significant differences), showed a tendency to carry out more activities that generate CES. This fact may contradict some studies that show a higher perception of services from the male perspective (Hartter 2010; Warren et al. 2011); and be in line with other works showing that women display a better environmental sensitivity, attitude and altruism (focused on conservation and perception of nature) than men (Dietz et al. 2002; Martino 2008). Our results, show that it would be interesting to consider gender differences in the perception of CES-generating activities, probably on similar grounds as Martino (2008).

Despite the abundance of studies on the perception of ecosystem services in rural areas (Bennett 2016; Ruiz-Frau et al. 2019), there are few that focus on the perspective of private landowners with respect to CES (Cortés-Capano et al. 2020). In addition, although individual landowners' actions demand activities that increase the contribution of these ecosystem services, research has revealed a lack of landowner information on knowledge related to ecosystem service management (Tengberg et al. 2012). This is striking given that rural landscapes in Spain, and particularly in Andalusia, represent a multiplicity of CES that, in part, sustain life, that is the persistence of local people, in these territories. The activities currently put into practice and considered to generate CES are those related to the sense of belonging to the region (e.g. those related to olive farming, by its tradition, culture, economic and social aspects; Torres-Miralles et al. 2017; but see also Escalera-Reyes 2020) and the practice of recreational hunting. These activities are highly valued by all clusters of landowners. Recreational hunting is a widespread activity and is proposed in various studies as a means of nature conservation and

livelihood support (Adams et al. 2009). However, at the same time, it is increasingly scrutinized on ethical grounds and on the grounds that it may threaten species and not contribute significantly to local livelihoods (Di Minin et al. 2021). In Spain, local people have generally supported this type of hunting because they see it as a viable economic alternative that contributes to the conservation of the territory (Martín-Delgado et al. 2022). Despite this, recent legislation prohibits hunting of ungulates in Protected Areas (Carpio et al. 2024). It is also interesting to note that in cluster 1, where a larger area of use linked to watercourses is identified, the role of public institutions in the maintenance of CES is more relevant. This perception might have to do with an effort to implement actions aimed at valuing CES linked to traditional water management practices, such as terraces, 'balates' or 'paratas' -small, narrow banal that was established on the sloping terrain of the sierras- waterwheels, irrigation ditches (Gómez-Baggethun et al. 2010; Isselhorst et al. 2018). In this way, concrete actions that seek to enhance the value of other CES are still pending, despite being identified as relevant by the inhabitants themselves.

The study area is fundamentally rural, and only the activities recognized by cluster 4 coincide with the preferences of urban dwellers. This may have to do with the fact that in cluster 4 there are no residential areas, therefore producers must move to urban centres, and farming is only an area with different agricultural activities (crops, grazing areas). The results are somewhat consistent with those obtained by Iniesta-Arandia et al. (2014), who found that recreational hunting is a critical service (important and vulnerable), while local identity is considered an invisible service in two river basins in Almería (Andalusia, SE of Spain). However, these authors also found that traditional agriculture, intrinsically linked to traditional ecological knowledge, was a very vulnerable service in both basins studied. This vulnerability is due to the basins' cultural genesis. This type of service is based on the insights acquired by rural people through their empirical knowledge. The abandonment of these traditional rural activities makes this acquired knowledge vulnerable. In this sense, the data from the respondents indicate that, although recreational hunting is a current activity perceived as a generator of CES, among the activities to be promoted, the activities related to traditional agriculture and water management (that is, local traditional ecological knowledge).

The study area has, in general, a positive disposition towards promoting and enhancing CES-generating activities that can be offered on private land, given the appropriate conditions and incentives. Knowing and understanding the main current and

potential activities on farms before designing policies is very important to tailor measures and incentives to the needs of each cluster of landowners in order to achieve maximum effectiveness (Howley 2013). In this sense, there is a considerable amount of European support for European farmers to maintain their rural activities and different specific cases were described (Balezentis et al. 2020; Balvanera et al. 2020; Kiryluk-Dryjska et al. 2020).

#### **4.2. Relevance of CES generating activities and contribution of traditional rural landscapes to local sustainability**

In the study area, regarding activities to maintain CES, a rigorous control is conducted of invasive species and pests that could negatively affect the ecosystems involved in the generation of CES. In addition, adaptation and management techniques are implemented that include the introduction of sustainable agricultural and livestock farming methods, the promotion of biodiversity in cultivated areas, and the application of innovative technologies (Rodríguez Sousa et al. 2019). Biological habitat management is another key strategy, with the aim of preserving and restoring the native ecosystems necessary for the provision of CES. In addition, road infrastructure, such as highways and roads, is constantly maintained to minimize the environmental impact and ensure adequate access to areas where ecosystem services are generated. This measure helps to prevent habitat fragmentation and maintain the functionality of ecosystems (Fiedler et al. 2008). Responsible waste management is another fundamental aspect in the CES conservation strategy, efficiently addressing the elimination and recycling of waste generated by agricultural and livestock activities. Finally, the continuous adaptation of management techniques stands is of particular importance, with the incorporation of practices and technologies that evolve in accordance with scientific advances and the demands of the environment.

Landscapes such as those present in our study area play an important role in improving air and water quality (affecting human health and well-being), are often associated with resilient and sustainable environments where there is a culture and sense of belonging inherent to the agricultural activities that take place and are almost always extensive. Furthermore, in the ongoing process of urban sprawl and population concentration in cities, rural areas play an essential role as reservoirs of biodiversity, as recipients of climate change adaptation projects and as spaces managed to contribute to climate change mitigation (Vimal et al. 2012; de Olivera Lc et al. 2023). Our results, in agreement with other authors (Slámová and Belčáková 2019; Ortiz et al. 2024), showed the

importance of considering the needs and demands of private landowners when establishing planning and management policies in rural areas for the sustainability of these traditional multifunctional (multiservices) socio-ecological landscapes.

Local sustainability in rural areas thus depends on the conservation of these landscapes, which are currently threatened by agricultural intensification and rural abandonment (Rescia et al. 2010). At regional level in the EU, where more than 60% of the population lives in areas considered rural, this sustainability must include the preservation of traditional farming practices, and the biocultural diversity linked to multifunctional rural landscapes. Such sustainability is framed by the original eight sustainable development goals set out in the Millennium Declaration (United Nations Millennium Declaration UNMD 2000) and the subsequent 2030 Agenda for Sustainable Development, with 17 Sustainable Development Goals (SDGs) (Nations 2015). These landscapes contribute directly, at a minimum, to SDGs 3, 11, 12, 13 and 15. A key strategy for achieving the sustainability of traditional rural landscapes is to analyse how private producers drive CES-generating activities and, on this basis, to design strategies to promote them.

#### **4.3. Possible strategies to conserve and implement CES-generating activities**

Given the heterogeneity between clusters, it would be complex to design a common strategy to maintain or strengthen CES. In addition, the policies to be applied should have a flexible framework for action that would consider the local socio-ecological context, in order to try to cover the different needs. Fons et al. (2011) propose three levels for policy implementation: a) individual, where the influence of cultural services on the behaviour and decisions of landowners is evaluated; b) community, where the practices that these services motivate among rural and urban societies are evaluated; and c) landscape, where the importance that the services offer in the management of the territory is evaluated. A good policy should cover all three levels.

To effectively promote CES in management models that encourage multifunctionality, different strategies have been selected that address the needs of landowners according to the results of this study. Within the cluster of private landowners, and considering the previously mentioned levels, it is feasible to define a specific strategy for each cluster identified in this study. First, a strategy based on stimulation, especially for landowners' cluster 2, which is mainly made up of farmers focused on maximising the yield of their farms and do not consider other land uses. These landowners showed a reserved attitude towards CES-generating activities. The stimulation tool involves: i) contracts and payments for ecosystem

services, ii) economic compensation in contexts of high social demand for cultural services, and iii) workshops and information programs highlighting the synergies of cultural services with regulating and provisioning services. This support would be attractive to landowners interested in economic benefits, long-term sustainability and willing to incorporate activities related to cultural services on their farms (Torralba et al. 2020). A strategy directed to facilitation would be suitable for landowners of clusters 1 and 3, who showed a positive attitude towards CES-generating activities, although their assessment was initially relatively low. The facilitation strategy would include: i) training and education programs and campaigns, ii) simplification of requirements mainly for accessing state funding. For cluster 3, state economic incentives would be added, as they show some reservation about the decision to include new activities in their farms (Torralba et al. 2020). Lastly, measures focused on innovation would be effective for landowners in cluster 4. This group of landowners promotes activities that generate CES and shows a positive attitude towards the initiative to encourage more activities of this type. The innovation strategy involves providing state financial support to implement innovative management models and new businesses. Through this strategy, scientific advances and new regulations will be evaluated. It is also important to generate strategies that make it easier for producers to access funding in other (non-state) areas to promote activities that generate CES. While the promotion and preservation of CES are essential for landscape planning and in the conservation of cultural heritage (Csurgó and Smith 2021), they do not always guarantee environmental sustainability, as they may perpetuate traditional practices that are not adapted to climate change and could even contribute to the degradation of the CES themselves (Plieninger et al. 2015).

## 5. Conclusions

The results of the study reveal that landowners with the greatest knowledge of CES-promoting activities tend to be older. This finding, in the context of the case study, is particularly relevant given the increasing rural abandonment. Therefore, this factor could be key in developing strategies to encourage young people to remain in the area or attract new young producers. These activities not only generate ecological benefits but also have a positive impact on the social and economic dimensions for the producers.

Although CES-generating practices such as invasive species control, habitat management for native species, waste management, and road infrastructure improvements may appear to offer little immediate socio-economic return for landowners, they actually enhance other activities related to the landscape,

cultural, and tourism value of the study area. This demonstrates that CES are not limited to the ecological sphere but encompass a wide range of integrated benefits for local communities.

Potential CES-generating activities are linked not only to a sense of belonging to the region and recreational hunting, but also to activities such as agro-tourism, regional research, and the observation of species of conservation interest. In this rural region, as in many rural landscapes, the control of invasive species and the maintenance of roads and trails as access routes are primarily practices for conserving and optimising CES generation. In this context, it is crucial to recognise the role of regional and national administrations in designing public policies, both in terms of incentives and funding, aimed at enhancing CES-generating activities. Although local public policies mainly focus on fostering heritage activities related to waterscapes, there are also activities on small- and medium-scale private properties that contribute significantly to CES provision and have so far not been recognised as a strategic focus in environmental policies. These properties present opportunities for stimulation, facilitation, and innovation.

In the study area, nature conservation goes beyond biodiversity preservation; it involves recognising and valuing landscapes shaped by human intervention. These spaces, often transformed into private estates, not only act as reservoirs and managers of biological diversity but also play a vital role in providing CES of great value to society. Consideration of natural and cultural aspects strengthens sustainable management practices and highlights the need to establish and maintain a meaningful connection between local communities and their environment.

It is therefore concluded that close collaboration with private landowners is a key strategy to ensure the sustainability and continuity of these landscapes and the provision of cultural ecosystem services. Moreover, the sustainability of these cultural landscapes directly contributes to Sustainable Development Goals (SDGs) 3, 11, 12, 13, and 15.

## Notes

1. <https://www.juntadeandalucia.es/institutodeestadisticaycartografia/dega/sistema-de-informacion-multiterritorial-de-andalucia-sima>.
2. <https://www.juntadeandalucia.es/medioambiente/portal/acceso-rediam>.

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No potential conflict of interest was reported by the author(s).

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