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Exploring social preferences for ecosystem services of multifunctional agriculture across policy scenarios

Alberto Bernués[a,b,*], Frode Alfnes[c], Morten Clemetsen[d], Lars Olav Eik[d], Georgia Faccioni[e], Maurizio Ramanzin[e], Raimon Ripoll-Bosch[f], Tamara Rodríguez-Ortega[a,b], Enrico Sturaro[e]

[a] Centro de Investigación y Tecnología Agroalimentaria de Aragón, Zaragoza, Spain
[b] Instituto Agroalimentario de Aragón – IA2 (CITA-Universidad de Zaragoza), Zaragoza, Spain
[c] School of Economics and Business, Norwegian University or Life Sciences, Ås, Norway
[d] Faculty of Landscape and Society, Norwegian University of Life Sciences, Ås, Norway
[e] DAFNAE – Università di Padova, Legnaro (PD), Italy
[f] Animal Production Systems Group, Wageningen University, Wageningen, The Netherlands

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ABSTRACT

Multifunctional agroecosystems are the result of complex adaptive interactions between humans and nature where trade-offs between food production and other ecosystem services are key. Our objective is to explore the social preferences for ecosystem services, and the associated willingness to pay, in three multifunctional agroecosystem in Europe (Mediterranean, Atlantic, Alpine) under alternative agrienvironmental policy scenarios. We use the same methodology (a choice experiment including equivalent attributes and levels) to rank and estimate the economic value of provisioning, regulating, supporting and cultural ecosystem services. We define the scenarios (current situation, abandonment and enhanced management) in biophysical terms to elucidate changing relations between social perception and level of delivery of ecosystem services. We derive some lessons. i) Value of ES: biodiversity and regulating ecosystem services always produce welfare gains; people, however, perceive trade-offs between delivery of agricultural landscapes and quality food products. Nevertheless, preferences are heterogeneous and vary across regions, scenarios and ES. ii) Policymaking: society's willingness to pay for the delivery of ecosystem service exceeds largely the current level of public support. Moreover, further abandonment and intensification of agriculture is clearly rejected by the public. iii) Methodological: monetary valuation is context dependent and extrapolation of economic values can be misleading.

1. Introduction

Agriculture in marginal lands, such as mountains or arid areas, constitutes a paradigmatic social-ecological system. These landscapes are the result of complex adaptive interactions between humans and nature that have occurred across spatial and temporal scales (Liu et al., 2007). For example, through the practice of the transhumance of livestock across seasons and regions to optimize the utilization of natural resources (Oteros-Rozas et al., 2013). Agriculture is multifunctional in these landscapes, delivering multiple ecosystem services (ES) to humans, both provisioning ES such as food products, and regulating, supporting and cultural ES, which normally constitute public goods. In Europe, the geographical distribution of *multifunctional agroecosystems* occupy 41.2% of the total utilized agricultural area (Schwaiger et al., 2012). However, these agroecosystems are in a continuous, often concurrent, process of abandonment and intensification, due to general socio-economic trends driven by the increasing opportunity cost of labor and changes in the relative prices of inputs and outputs (Strijker, 2005). Agricultural policies, specifically the European Common Agricultural Policy (CAP), recognizes the multifunctionality of particular agricultural systems and aim, at least in its spirit, at increasing the provision of public goods. However, the CAP has so far failed to do so (Erjavec and Erjavec, 2015; Pe'er et al., 2019), due to distribution of budgetary resources, the choice of instruments and the design and implementation of policy measures (Cooper et al., 2009). Scenario analysis can help exploring *ex-ante* the outcomes of alternative policy settings in terms of provision of public goods by defining potential but realistic trends in agricultural land use at European scale.

* Corresponding author at: Centro de Investigación y Tecnología Agroalimentaria de Aragón, Zaragoza, Spain.
E-mail address: abernues@aragon.es (A. Bernués).

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Table 1
Main characteristics of the areas under study.

Agroecosystem and country	Location and size	Farming systems and land use	Trends
Mediterranean (Spain)	Guara Natural Park (47º17'N, 0º13'W) 807 km^2	Meat sheep and mixed sheep-crops systems. Agricultural area devoted to shrub rangelands, forest and crops. Main crops include forages, permanent crops (mainly olive trees) and cereals.	Low continuity of family farms, reduction of grazing and abandonment of remote areas. Vegetation encroachment and landscape closure. High demand for tourism and recreation.
Atlantic (Norway)	Aurland municipality (60º52'N, 7º14'E) 1468 km^2	Meat sheep and dairy goats. Agricultural area devoted to natural grasslands, forests and scarce agricultural areas in lowlands for cultivated grasslands, fruits and berries.	Strong reduction of agriculture in the past, stabilized now. Vegetation encroachment and landscape closure. Major tourism attraction in Norway.
Alpine (Italy)	Trento province (46º04'N, 11º07'E) 6200 km^2	Dairy cattle for cheese production. Agricultural area devoted to fruits, vineyards and meadows in valleys and natural pastures in mountains. Fruits and vineyards rapidly increasing in valleys.	Abandonment of mountain farms and intensification of crops in valleys. Vegetation encroachment and landscape change. High demand for tourism and recreation.

The existence of trade-offs between the provision of private and public goods (typically between food production and non-marketable ES) is a key feature in multifunctional agroecosystems (Kovács et al., 2015; Ripoll-Bosch et al., 2012). They are traditionally considered as low-input/low-output, implying a reduced use of off-farm resources and productivity. In contrast, these agroecosystems can provide a wide range of benefits and services to society. Nevertheless, since they have no market price, farmers have little or no incentives to produce them regardless of their high societal demand (Cooper et al., 2009).

To correct this situation, equitable and effective agrienvironmental policies need to be designed. On the production side, there is a need to measure in biophysical terms the range of services that farmers provide, for example by analyzing the effect that particular agricultural practices have on biodiversity (Rodríguez-Ortega et al., 2018). On the demand side, it is necessary to understand how the public perceive the relationships between agriculture and the environment (Bernués et al., 2016), identify the most demanded ES that should guide policy targets, and pay famers for the delivery of these ES. Despite economic valuation of ES is controversial (Gómez-Baggethun and Ruiz-Pérez, 2011; Laurans and Mermet, 2014), when combined with socio-cultural and biophysical approaches, it can help in prioritizing conservation objectives, quantifying trade-offs among different management options, or estimating the amount of money that society is willing to pay for ES.

Despite the literature on economic valuation is rapidly increasing, a number of challenges remain. First, location-specific ecological and social-economic factors determine the ES delivery and value (Randall, 2002). Therefore, comparing economic value between places or aggregating this value to larger scales may become problematic. Benefit transfer methods aim at transposing the value estimates across locations, adjusting for differences in ecological and economic contexts (Pascual et al., 2010), however there are major sources of uncertainty that question the validity of transferred values (Huber et al., 2018; Schmidt et al., 2016). Second, there is a substantial gap between research and the informational needs of decision makers and practitioners (Olander et al., 2017). Decision processes are normally taking place at local or regional scales, where tangible problems relevant to stakeholders occur (Fischer et al., 2015; Tammi et al., 2017). Yet, valuation models tend to focus on biophysical outcomes (ES) that do not always matter to people, or do not represent the interplay of biophysical, ecological and social components at relevant temporal and spatial scales (Costanza et al., 2017). In addition, valuation methods are rarely comparable as they are developed to address specific problems and repeatability is rarely feasible (Small et al., 2017). Third, most studies are not capable of estimating the changes in value arising from changes in management or policies (Olander et al., 2017). Nature-human relationships are dynamic, often nonlinear and can reveal trade-offs among ES. Defining alternative policy scenarios, representing complex but plausible futures, can help investigating how value evolves by linking landscape changes to ES delivery (Plieninger et al., 2013). Finally, the disaggregation of the beneficiaries of ES is key to analyze trade-offs and inform policy to resolve potential conflicts among them (Martín-López et al., 2012). Moreover, few studies analyze the heterogeneity of preferences within social groups, despite a greater knowledge of the underlying attitudes and motivations of lay people can increase the public support for agrienvironmental and conservation policies (Rodríguez-Ortega et al., 2016).

The main objective of this study was to explore the social preferences for ecosystem services, and the associated willingness to pay, in three multifunctional agroecosystem in Europe (Mediterranean, Atlantic, Alpine) under alternative agrienvironmental policy scenarios. To do so, we first analyze how the preferred level of delivery of ecosystem services (provisioning and non-provisioning) differ from the current level; then we analyze how these preferences, and their heterogeneity, change across policies and regions; and finally we calculate the total willingness to pay of society for the delivery of the ES, as a proxy to estimate the total economic value of multifunctional agroecosystems.

2. Methodology

2.1. Agroecosystems and ecosystem services

This study covers the three largest terrestrial biogeographical regions in western Europe holding multifunctional agroecosystems: Mediterranean, Atlantic and Alpine. Table 1 summarizes the main characteristics of the agroecosystems; further biogeographical information on the study areas can be obtained from Bernués et al. (2014), Bernués et al. (2015) and Faccioni et al. (2019), for Mediterranean, Atlantic and Alpine agroecosystems, respectively.

The ES under consideration in each agroecosystem were derived from previous socio-cultural analyses (focus groups in Mediterranean and in-depth interviews in the Atlantic and Alpine agroecosystems), as described by Bernués et al. (2014), Bernués et al. (2015) and Faccioni et al. (2019). These ES, which were identified as the most important by the public, were (i) the preservation of agricultural landscape (cultural ES); ii) the conservation of biodiversity (supporting ES); (iii) the prevention of forest fires in Mediterranean conditions, the maintenance of soil fertility in Atlantic conditions and the preservation of water quality in Alpine conditions (regulating ES); and iv) the provision of specific quality food products linked to the agroecosystems (provisioning ES).

2.2. Economic valuation

2.2.1. Choice experiment

We used choice modeling to assess the relative importance of individual ES and the willingness to pay (WTP) of the populations under study. The ES corresponded to the four types of the Economics of Ecosystems and Biodiversity (TEEB) taxonomy (Kumar, 2010) (provisioning, regulating, supporting and cultural). We assumed that these ES embodied the most important use and non-use values of the Total Economic Value (TEV) (Pearce and Pretty, 1993). Choice experiments are one of the few methodologies able to estimate all use and non-use values of the TEV taxonomy (Rodríguez-Ortega et al., 2014).

In choice modeling, we used individuals' stated behavior in a hypothetical choice setting to derive the value of nonmarket goods (Hensher et al., 2005). Each respondent was asked to choose his most preferred alternative of five choice situations defined in terms of policy scenarios described by their ES biophysical attributes (Table 2).

For each choice situation, one of the scenarios was fixed (the current policy) and represented the current situation in the respective study areas. The other two scenarios in each choice situation were referred to as policy A and B and were represented with different combinations of attribute levels (Table 2). These were contrasting policy scenarios that we call here 'liberalization' and 'targeted support' representing two consistent macroeconomic framework conditions. The general rationale for the scenarios was as follows. The liberalization of policy assumed a reduction in support for agrienvironmental schemes and a subsequent acceleration of the processes of abandonment of the most marginal lands and the intensification and homogenization of production systems in the most favorable lands. Consequently, a process of landscape closure and homogenization, loss of biodiversity, erosion of regulating ES and lower availability of quality products linked to the territory was hypothesised. The targeted support scenario represents an alternative policy that leads to additional funding for agrienvironmental schemes, specifically designed to deliver higher levels of public goods. Hence, higher levels for the abovementioned ES was expected. Full details of scenario definition, attributes and levels are described in detail in Appendix A.

2.2.2. Survey and questionnaire

The survey was designed to collect responses from the general populations (above the age of 18) in the regions nearby the agroecosystems under consideration. The regions were Aragon administrative region in Spain ($N > 18 = 1,103,864$ inhabitants), Bergen municipality in Norway ($N > 18 = 271,949$) and the Provinces of Belluno, Bolzano, Brescia, Sondrio, Verona, and Vicenza in Italy ($N > 18 = 3,265,736$). Sample sizes collected were 402, 240 and 402, respectively. Date of data collection was July 2013, June 2014 and July 2016, respectively. The questionnaires were implemented through three professional online panels that were representative of the adult population (above 18 years old) in the respective areas according to gender, age and place of residence. The panellists were selected randomly and recruited by invitation only to ensure representativeness. All responses provided by the professional panel were complete and used for analysis.

The questionnaire was formulated equally for all study areas and translated to the native languages. Before the choice options, basic information on the agroecosystems that are present, the ES attributes, the existing agrienvironmental policies, and the societal cost of policy was supplied. We made it explicitly clear that the societal cost of each choice corresponded to the amount of money that each member of a family who was above the age of 18 would have to pay as an annual tax. The original questionnaires (block 1) can be seen in Appendix B.

Given the large number of combinations of attributes and levels ($3^4 * 5^1 = 405$) we used the software Ngene (Choice Metrics, Ltd.) to develop an efficient experiment design that included a fraction of these combinations. Thirty choice sets divided in six blocks were obtained, i.e., each respondent made five choices. The design used prior parameter estimates obtained in a previous test survey. We carefully checked all the choice options for illogical or counterintuitive patters. In addition, the questionnaire was tested face-to-face to detect problems with particular choice settings. Policy scenarios were unlabelled to ensure that respondents focussed on the attribute combinations without their choices being affected by policy names.

2.2.3. Data analysis

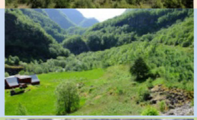
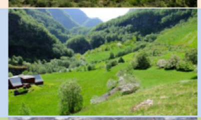
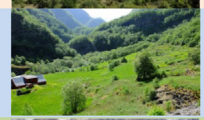
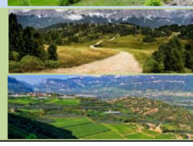
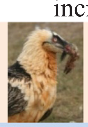
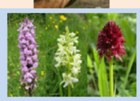
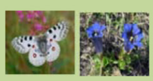
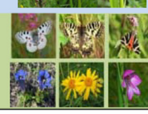
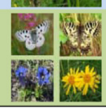
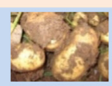
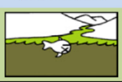
When individuals made their choice, they had to make a trade-off between the levels of the attributes and the costs that were associated with the different policies in the choice set. To estimate the effect of the different attributes on the choices the respondent made, we used a mixed logit model. Mixed logit models explicitly assume that there is a distribution of preference weights across the sample reflecting differences in preferences among respondents, and it models the parameters of that distribution for each attribute level (Hauber et al., 2016), which allows for unobserved preference heterogeneity among the respondents to be revealed (Revelt and Train, 1998). Parameter estimates indicated the effect of the attributes on the probability of choice of an alternative. Positive parameter values indicated that the presence of the attribute in a policy scenario increase the choice probability of that scenario, and negative values indicated a reduction in choice probability. The relative size of the parameters within one sample can be used to calculate the respondents' marginal rate of substitution between the attribute levels, and the marginal WTP for the attribute levels.

We used these marginal WTP estimates in our calculations of TEV of the policy scenarios, taking as reference the targeted support scenario. We calculated the WTP for each of the attributes included in the choice experiment by dividing the absolute value of the estimates of the highest levels of the attributes by the absolute value of the estimate for the annual cost. Then, we calculated the TEV by summing the partial WTP for the individual ES, as proxies to the different values of the TEV taxonomy (Table 1).

3. Results

Table 3 shows the results of the mixed logit model used to analyze the choice experiment data from the participants in Mediterranean, Atlantic and Alpine agroecosystems. The parameter estimates indicate preference for changes relative to the current situation. All parameter estimates show the expected sign. Positive estimates means that respondents preferred (obtained welfare gains from) the level of delivery of a particular ES (i.e. rich landscape mosaic, biodiversity increase,

Table 2
Attributes and levels (status quo underlined) as represented in the choice sets and components of Total Economic Value.

Attribute (type and ES)	Levels						TEV[3] component
Cultural ES	abandonment[1]		rich mosaic		current landscape		
Landscape (Mediterranean)							Non-extractive direct use value (recreation)
Landscape (Atlantic)							
Landscape (Alpine)							
Supporting ES	decreased		increased		current level		
Biodiversity (Mediterranean)		7 pairs of bearded vulture		15 pairs bearded vulture		11 pairs of bearded vulture	Non-use existence value (preservation of biodiversity)
Biodiversity (Atlantic)		floristic diversity decreases		floristic diversity increases		floristic diversity maintained	
Biodiversity (Alpine)		butterflies & flowers decrease		butterflies & flowers increase		butterflies & flowers maintained	
Regulating ES	decreased		increased		current level		
Forest fires (Mediterranean)		6 forest fires per year		2 forest fires per year		4 forest fires per year	Indirect use value (indirect benefits)
Soil fertility (Atlantic)		soil fertility decreases		soil fertility increases		soil fertility maintained	
Water quality (Alpine)		rivers very polluted		clean water in rivers		rivers slightly polluted	
Provisioning ES	decreased		increased		current level		
Quality products (Mediterranean)		2 quality products		6 quality products		4 quality products	Extractive direct use value (food)
Quality products (Atlantic)		2 quality products		6 quality products		4 quality products	
Quality products (Alpine)		9 quality cheeses		17 quality cheeses		13 quality cheeses	
Annual cost (€) [2]							
(Mediterranean)	15	30	60		75	45	
(Atlantic)	20	60	140		180	100	
(Alpine)	10	20	40		50	30	

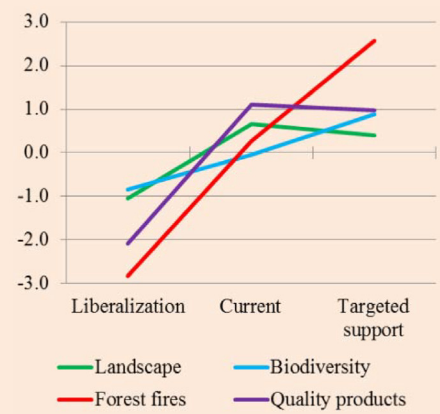
[1]In the Alpine agroecosystem, this scenario considers both abandonment in mountain areas and intensification in valleys.
[2]Cost of the status quo is the average cost per person above 18 of agrienvironmental measures in the respective areas of study. Note that the annual cost has five levels as it is treated as a continuous variable.
[3]Total Economic Value.

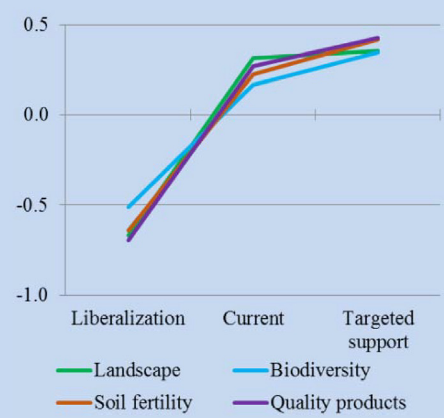
forest fires decrease, soil fertility increase, water quality increase and higher number of quality products). Negative estimates, in contrast, means that respondents disapproved (obtained welfare loses from) the level of delivery of a particular ES (i.e. abandonment of agricultural landscapes, biodiversity decrease, forest fires increase, soil fertility decrease, water quality decrease and lower number of quality products). The estimates for ES are significant (between 1 and 10% significance level) except for the high level of provision of quality products

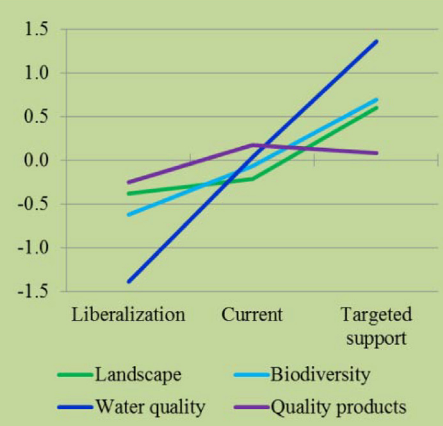
Table 3
Mixed logit model results and estimates evolution across scenarios for Mediterranean, Atlantic and Alpine agroecosystems.

	Parameter	Estimate	St. error	t Value	P
Mediterranean	Landscape rich mosaic	0.3982	0.2171	1.83	0.0666
	Landscape abandonment	-1.0471	0.3066	-3.41	0.0006
	Biodiversity increase	0.8877	0.3069	2.89	0.0038
	Biodiversity decrease	-0.8434	0.2947	-2.86	0.0042
	Forest fires increase	-2.8342	0.9871	-2.87	0.0041
	Forest fires decrease	2.5707	0.8265	3.11	0.0019
	Quality products 6	0.9789	0.4158	2.35	0.0186
	Quality products 2	-2.0904	0.7382	-2.83	0.0046
	Annual cost (tax)	-0.0399	0.0121	-3.30	0.0010
	No. respondents 402; No. observations 2010				
	Log likelihood -1892; McFadden LRI 0.143				
Atlantic	Landscape rich mosaic	0.3561	0.0817	4.36	<.0001
	Landscape abandonment	-0.6692	0.0815	-8.21	<.0001
	Biodiversity increase	0.345	0.075	4.6	<.0001
	Biodiversity decrease	-0.513	0.0932	-5.51	<.0001
	Soil fertility increase	0.4153	0.0846	4.91	<.0001
	Soil fertility decrease	-0.6408	0.0845	-7.58	<.0001
	Quality products 6	0.4264	0.0757	5.63	<.0001
	Quality products 2	-0.6939	0.0839	-8.27	<.0001
	Annual cost (tax)	-0.000216	0.000131	-1.65	0.0995
	No. respondents 240; No. observations 1200				
	Log likelihood -1111; McFadden LRI 0.150				
Alpine	Landscape rich mosaic	0.6007	0.0646	9.3	<.0001
	Landscape abandonment	-0.3820	0.0585	-6.53	<.0001
	Biodiversity increase	0.6890	0.0622	11.08	<.0001
	Biodiversity decrease	-0.6200	0.0733	-8.46	<.0001
	Water quality increase	1.3559	0.0916	14.81	<.0001
	Water quality decrease	-1.3880	0.0961	-14.44	<.0001
	Quality products 17	0.0787	0.0597	1.32	0.1875
	Quality products 9	-0.2495	0.06	-4.16	<.0001
	Annual cost (tax)	-0.0171	0.00401	-4.26	<.0001
	No. respondents 402; No. observations 2010				
	Log likelihood -1828; McFadden LRI 0.172				

Estimate evolution across scenarios







in the Alpine agroecosystem ($P = 0.187$). The annual cost has as expected a negative sign, meaning that respondents preferred to pay lower taxes, all else being equal.

The evolution of estimates across scenarios is plotted in the last column of Table 3. In general, the estimates for the liberalization scenario are greater in absolute value than the estimates for the targeted support scenario. In other words, the welfare gain that accrued from preventing abandonment was greater than the welfare gain that accrued from enhancing ES from agricultural activity (when compared with the current scenario). This happened in all agroecosystems and ES, except for landscape and biodiversity in the Alpine agroecosystem. However, the pattern of evolution of ES estimates across scenarios

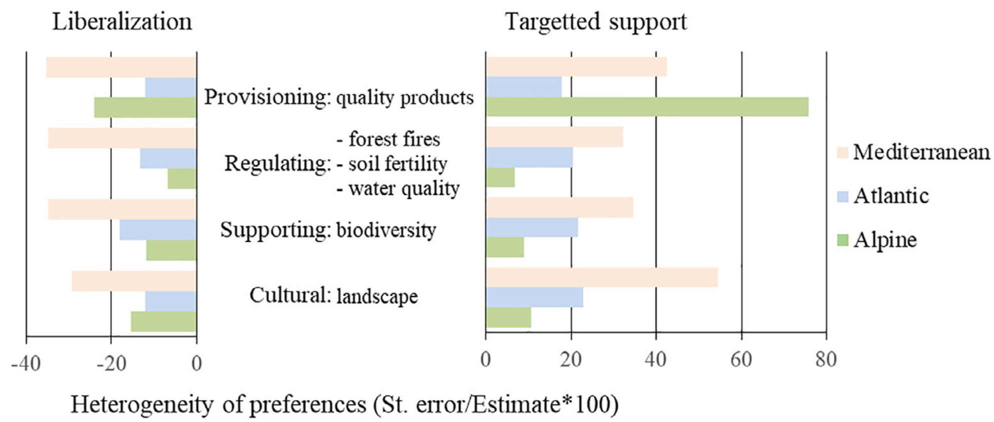


Fig. 1. Heterogeneity of preferences for ES in the liberalization and targeted support scenarios for Mediterranean, Atlantic and Alpine agroecosystems.

varies. For some, the pattern from the liberalization to the targeted support scenarios is close to linear (e.g. forest fires in the Mediterranean agroecosystem and water quality and biodiversity in the Alpine agroecosystems). For others, the evolution of estimates shows a non-linear pattern (i.e. discontinuity in the current scenario), particularly intense in the case of conservation of landscape and provision of quality products.

We selected mixed logit models because they yield both the mean and the standard deviation of effects across the samples. The heterogeneity of preferences calculated by the mixed logit model among respondents is represented in Fig. 1. In general, the targeted support scenario shows greater heterogeneity of responses (people differed more in their responses) than the liberalization scenario (people concurred more in their responses). The Mediterranean region shows the greatest heterogeneity of responses among respondents and the Alpine region the lowest. Exceptions are the provisioning of quality products linked to the territory in the targeted support scenario (highest heterogeneity in the Alpine region) and in the liberalization scenario (intermediate heterogeneity in the Alpine region), and the agricultural landscape in the liberalization scenario (intermediate heterogeneity in the Alpine region). Within regions, Mediterranean people showed the greatest heterogeneity for a rich mosaic agricultural landscape, and the lowest for reduction of forest fires and for the abandonment of agricultural landscape. Atlantic people showed very similar level of heterogeneity of responses for all ES and scenarios. Alpine people showed the greatest discrepancy of preferences for the delivery of quality products, as mentioned before, but agreed about the importance of water quality in the two scenarios.

WTP and TEV results are expressed as € per person per year, as cost was included in the model in this manner. Table 4 shows ES in order of importance (regarding WTP) in each agroecosystem. In the Mediterranean agroecosystem, the prevention of forest fires was the most important ES (more than 50% of total WTP), followed by the provision of quality foods, the conservation of biodiversity and cultural landscapes. In the Atlantic agroecosystem, all ES had similar importance, with the provision of quality foods and maintenance of soil fertility having slightly more WTP. In the Alpine agroecosystem, the preservation of water quality was the most important ES (50% of total WTP), followed by biodiversity, landscape and, with much lower WTP, the provision of quality foods.

TEV was 121.2€ (2.7 times the tax reference in choice experiment) for the Mediterranean agroecosystem, 715.0€ (7.1 times) for the Atlantic agroecosystem, and 159.3€ (5.3 times) for the Alpine agroecosystem. WTP was recalculated according to the average wage in each country, taking as reference the average wage in Spain (see Table 4 footnotes for details). In this case, the wage equivalent TEV was 121.2€, 510.1€ and 169.5€, respectively.

4. Discussion

4.1. Value of ES and interrelations among them

The evolution of the value of particular ESs varied greatly, as did the level of heterogeneity of responses among individuals. Regarding landscape, by definition its appreciation is subjective and therefore difficult to include in choice models or other valuation exercises (Daniel et al., 2012). Socio-cultural background and the former trajectory in terms of land use and land cover seemed key factors in landscape appreciation. In the Mediterranean and Atlantic agroecosystems, the landscape of the current and targeted support scenarios received similar appreciation, which implied that further agricultural development was not a priority, or even slightly rejected (Mediterranean agroecosystem). In the Alpine agroecosystem, the landscape that keeps mountain farming and a moderate intensification of agriculture in valleys was clearly preferred, probably because abandonment and intensification in the current landscape has already gone too far in the eyes of respondents (Faccioni et al., 2019).

Biodiversity conservation was perceived similarly across agroecosystems. This ES had moderate estimates in absolute value (i.e. its relative importance was intermediate: 18.4–25.3% of total WTP). The comparatively low importance assigned to biodiversity could be because the links with human well-being are not immediate or not easily perceived. People tend to value more those ES that have direct effects and satisfy more tangible needs (Hartter, 2010; Olander et al., 2017). However, biodiversity followed a linear pattern across scenarios, so people always obtained moderate welfare gains from increasing biodiversity through policy scenarios.

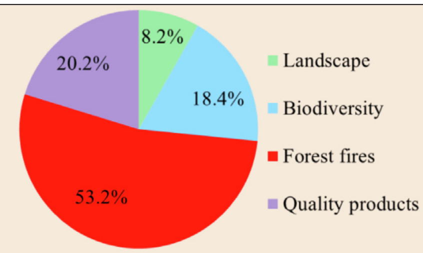
Regulating services also showed a linear evaluation across scenarios. These ES were very important in all cases (around 50% of total WTP for forest fires and water quality and 27% for soil fertility) for a majority of people (lower level of heterogeneity of responses in the two policy scenarios). However, regulating ES were rated differently across agroecosystems, which confirmed the need of previous socio-cultural studies to choose relevant ES -for people- before analyzing their economic value (Martín-López et al., 2014). The prevention of forest fires in the Mediterranean (located in a sparsely populated area with abandonment of large marginal areas) and the maintenance of water quality in the Alpine agroecosystem (located close to a very populated region with high agriculture development) have a perceived direct impact on people wellbeing. Consequently, the importance attached by the participants was large and homogeneous. Moreover, people were not willing to compromise on these two ES and welfare gain was linear across scenarios.

Differentiated quality products are often neglected in ES valuation exercises, as food is normally considered in terms of food security (bulk quantity). However, food quality has demonstrated to be a distinctive

Table 4
Willingness to pay (WTP) (€ per person per year) for the delivery of ecosystem services in the "targeted support" scenario and Total Economic Value (TEV) in Mediterranean, Atlantic and Alpine agroecosystems.

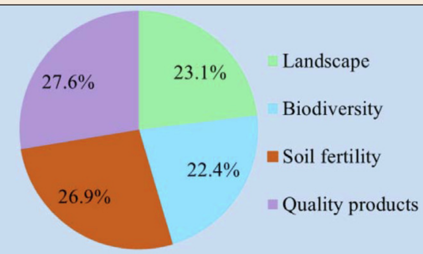
% of WTP | WTP and TEV (€ person^{-1} year^{-1})

Mediterranean



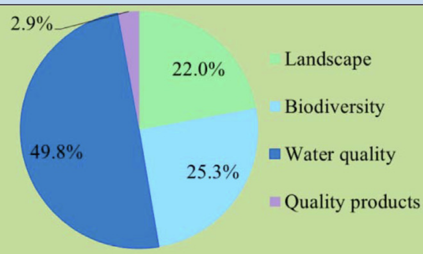
ES	WTP	WTP wage eq.[3]
Landscape	10.0	10.0
Biodiversity	22.2	22.2
Forest fires	64.4	64.4
Quality products	24.5	24.5
TEV[1]	121.2	121.2
(times tax ref.)[2]	(2.7)	

Atlantic



ES	WTP	WTP wage eq.
Landscape	165.0	117.8
Biodiversity	159.9	114.1
Soil fertility	192.5	137.4
Quality products	197.5	140.9
TEV	715.0	510.1
(times tax ref.)	(7.1)	

Alpine



ES	WTP	WTP wage eq.
Landscape	35.1	37.4
Biodiversity	40.3	42.9
Water quality	79.3	84.4
Quality products	4.6	4.9
TEV	159.3	169.5
(times tax ref.)	(5.3)	

[1]TEV = sum of WTP of non-extractive direct use value (landscape), non-use existence value (biodiversity), indirect use value (forest fires, soil fertility and water quality for Mediterranean, Atlantic and Alpine agroecosystems, respectively) and extractive direct use value (quality products).
[2]Tax reference was 45, 100 and 30€ per person per year for Mediterranean, Atlantic and Alpine agroecosystems, respectively.
[3]WTP wage equivalent was calculated according to OECD average country wages in 2015 (37259US$ in Spain, 35117US$ in Italy and 54629US$ in Norway), considering as base the average wage in Spain https://data.oecd.org/earnwage/average-wages.htm.

feature of multifunctional agroecosystems (Bernués et al., 2016). An intriguing outcome of our analyses is the changing public perception of this provisioning service across scenarios, which suggest a non-linear pattern and strong contextual and individual differences. In places where the current provision of quality products is high (in Mediterranean and more intensely in Alpine agroecosystems) many people are willing to compromise on the number or quality products in the target support scenario, but not on biodiversity and regulating services as previously mentioned. In Atlantic conditions, where quality products are not so abundant, the importance attached to them is the highest (with the lowest heterogeneity of responses), and the public always obtain welfare gains across scenarios.

4.2. Policy implications

Both abandonment and intensification of agroecosystems were rejected by the public. In general, the loss obtained from reduced levels of ES in the liberalization policy was larger than the gains from increased levels in the targeted support scenario. This asymmetry of welfare variation around the status quo scenario was observed in the Mediterranean and Atlantic agroecosystems, where the main problem is abandonment. This finding is consistent with the large literature on loss aversion in behavioral economics, which shows that losses have greater impacts on preferences than gains (Tversky and Kahneman, 1991). Psychological explanations for this asymmetry include ethical dimensions and the sense of moral responsibility or affection towards other people or the environment (Brown and Gregory, 1999; Peters et al., 2003). However, in the Alpine agroecosystem, where intensification and abandonment coexist and are visible in the same area, the gains of the targeted support scenario (which means a de-intensification of agriculture) had similar relevance to the losses due to the liberalization scenario that produced an increment of ecosystem disservices, water pollution in particular.

More generically, these results give empirical evidence to the theory of a displacement of the modernization paradigm in European agriculture by a sustainability/rural development paradigm (van der Ploeg et al., 2000). Today, urban citizens expect the countryside to provide much more than cheap food products and new needs and expectations must be satisfied by agriculture, which is therefore considered multifunctional (Renting et al., 2009). Respondents preferred a multifunctional configuration of agricultural systems oriented towards a mix of quality products, landscape management, biodiversity conservation and improvement of regulating services. This suggests a "land-sharing" model of agriculture as the desirable pathway for sustainable rural development (Pedroli et al., 2016), at least in the European context.

For effective design and implementation of agrienvironmental policies, we need to be aware of the potential changes in the value of ES arising from the different levels of provisioning as consequence of changes in management regimes or policies (Olander et al., 2017), as well as trade-offs between ES that also can change (e.g. provision of quality food products and regulating services). We believe it is wise to focus on particular ES that matter to people at the right local/regional spatial scales. In the three case studies, regulating ES and biodiversity showed consistent increments of WTP across scenarios; however, the WTP for regulating ES (specially prevention of forest fires and maintenance of water quality) was much higher. Regulating ES are perceived as having direct effects on human wellbeing and therefore may constitute better "entry points" to convince people of the need to preserve (agro-) ecosystems. Eventually, this strategy could contribute to increase policy acceptance and effectiveness. It derives that the optimal scale for policy implementation might not be political, but one in which social and environmental systems share their boundaries (Small et al., 2017).

Agrienvironmental schemes with targeted objectives, and the corresponding indicators that demonstrate the societal gains or losses, should contribute to reverse the abandonment/intensification trend that is widely rejected by the public. There is room for manoeuvre, as the WTP of the population is three to seven times larger than the current social cost in the respective locations. However, better targeted agrienvironmental policy should not necessarily mean a higher social cost (i.e. higher taxes). Economic resources of agricultural policies (e.g. the Common Agricultural Policy of the European Union) could be reallocated following a "provider gets" principle (i.e. moving from subsidies to increase farmers' rents to payments for their services to society).

4.3. Methodological implications

Our approach aimed at addressing some of the challenges of economic valuation of ecosystem services as described in the introduction, such as: the dynamic relations between humans and nature, the gap between research results and information relevant for decision-making at a definite scale, the lack of repeatability of many valuation studies, and the heterogeneity of value perception in the population.

To address the changes of value arising from different levels of delivery to ecosystems services, we defined realistic contrasting policy scenarios with biophysical effects tailored to the different multifunctional agroecosystems. We made some assumptions to link the policies to the level of delivery of ES (detailed in Appendix A). These assumptions were specific for the different indicators representing the ES in each location. To make results relevant for management, we chose the ES that matter to people, according to previous socio-cultural studies; moreover, in the considered agroecosystems the study areas were delimited on the basis of administrative units (different types of governances: natural park, municipality or province). A different representation of these ES (in particular the manipulation of pictures to represent land use intensities and the indicators of biodiversity) might have altered the final WTP values, which need to be used with caution. We also assumed that respondents understood the rationale of the experiment and further that they understood complex environmental phenomena and made rational choices. Yet, the results showed consistent patterns; some were general, whereas others were influenced by the socio-cultural contexts in which the agroecosystems were located.

Repeatability in valuation exercises is impaired due to high cost of time and resources, and the heterogeneity of local conditions (e.g. in this study, different regulating ES were important across populations as detected by previous socio-cultural studies). The replication of the analysis in the three agroecosystems showed that the economic value of ES depended on model specification (especially tax reference which depends on number of taxpayers in the study area) (Tammi et al., 2017), but also on economic and socio-cultural context (Randall, 2002). There were differences due to income level, but even when wealth of the population average was considered, the differences between countries were still large. It is possible that in the Atlantic case, where WTP was substantially higher, a number of people might not attend to the cost attribute relative to the ecosystem services attributes (Bernués et al., 2015). Consequently, the TEV varied greatly across agroecosystems, although it was always much larger than the current cost for the taxpayers. Taking into account that we used the same methodological framework and a similar model specification in terms of ES and change in provision levels, this finding opens up questions around the usability of monetary values estimated with stated-preference methods and the benefit transfer approach, even if adjusted to income level, to enlarge the scale of economic assessments (Plummer, 2009). Historical and cultural differences between countries can play a major role when explaining the differences of current and future use values in very specific local contexts (Brouwer, 2000). As mentioned above, current values need to be compared with caution. In addition, other studies have demonstrated that, within countries, WTP varies enormously among geographical location of the population (rural versus urban) and psychographic (conservationists vs. productivists) profiles (Rodríguez-Ortega et al., 2016). The different degree of heterogeneity of responses across ecosystems services underlines the variation within the population and indicates an area for further research.

5. Conclusion

Our approach allowed visualizing the changing relationships between (agro-) ecological and social subsystems by quantifying the societal demand of ES across diverse policy scenarios defined in levels of biophysical delivery. A number of lessons could be derived. 1 – The WTP for the provision of ES exceeded the current level of public support so there is room for further investment or reallocation of resources in agrienvironmental policies. 2 – Further abandonment and intensification of agriculture were clearly rejected by the public. Respondents preferred a multifunctional configuration of agricultural systems oriented towards a mix of quality products, landscape management, biodiversity conservation and improvement of regulating services. 3 – Monetary valuation with stated preference methods is highly dependent on context, therefore it can help in ES prioritization but extrapolation of economic values can be misleading. 4 – Increasing the provision of biodiversity and specially regulating ES always produced welfare gains, however, the optimal level of delivery of agricultural landscapes and quality products was context dependent and people perceived trade-offs between ES across policy scenarios.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecoser.2019.101002.

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