

A shepherd in a blue jacket is herding a large flock of sheep in a green field. In the background, there are rolling hills, a small village with white buildings, and a range of mountains under a blue sky with some clouds.

Quantifying multifunctionality of pasture-based livestock systems in Mediterranean mountains

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Outline

1. Multifunctionality, public goods and ecosystem services
2. How to value non-market goods (ES)
3. Example in Euro-Mediterranean HNV farmland
 - Socio-cultural valuation
 - Economic valuation



Multifunctionality and public goods

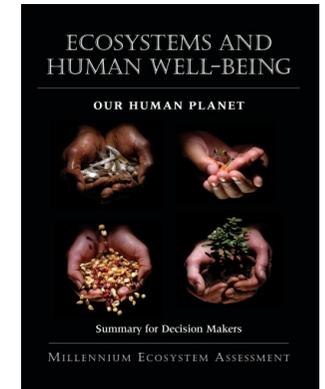
Multifunctionality is a systems oriented concept. It addresses the fact that in addition to the provision of private goods like food and fibre, agriculture can provide a set of **public goods**.

Some central public goods in Europe are:

- **Landscape & biodiversity** values: cultural heritage, amenity value of the landscape, recreation/access, scientific/educational value.
- **Food** related aspects: food safety and food quality.
- **Rural activity**: rural settlement and economic activity.

Ecosystem services

Humankind **benefits** from a multitude of resources and processes that are supplied by natural ecosystems, including **agro-ecosystems**.



- **Provisioning**: products obtained from the ecosystem, i.e. food, timber, fiber, water, etc.
- **Regulating**: benefits obtained from the regulation of ecosystem processes, i.e. regulation of climate, erosion prevention, water regulation, etc.
- **Cultural**: nonmaterial benefits people obtain from ecosystems, i.e. spiritual enrichment, cognitive development, recreation, aesthetic experience, etc.
- **Supporting**: ecosystem services that are necessary for the maintenance of all other ecosystem services, i.e. primary production (photosynthesis), soil formation, nutrient cycling, etc.



Ecosystem Services valuation

- Different functional units
- Different temporal and spatial scales
- Different perceptions by society
- No market price

1. BIOPHYSICAL
2. SOCIO-CULTURAL
3. ECONOMIC

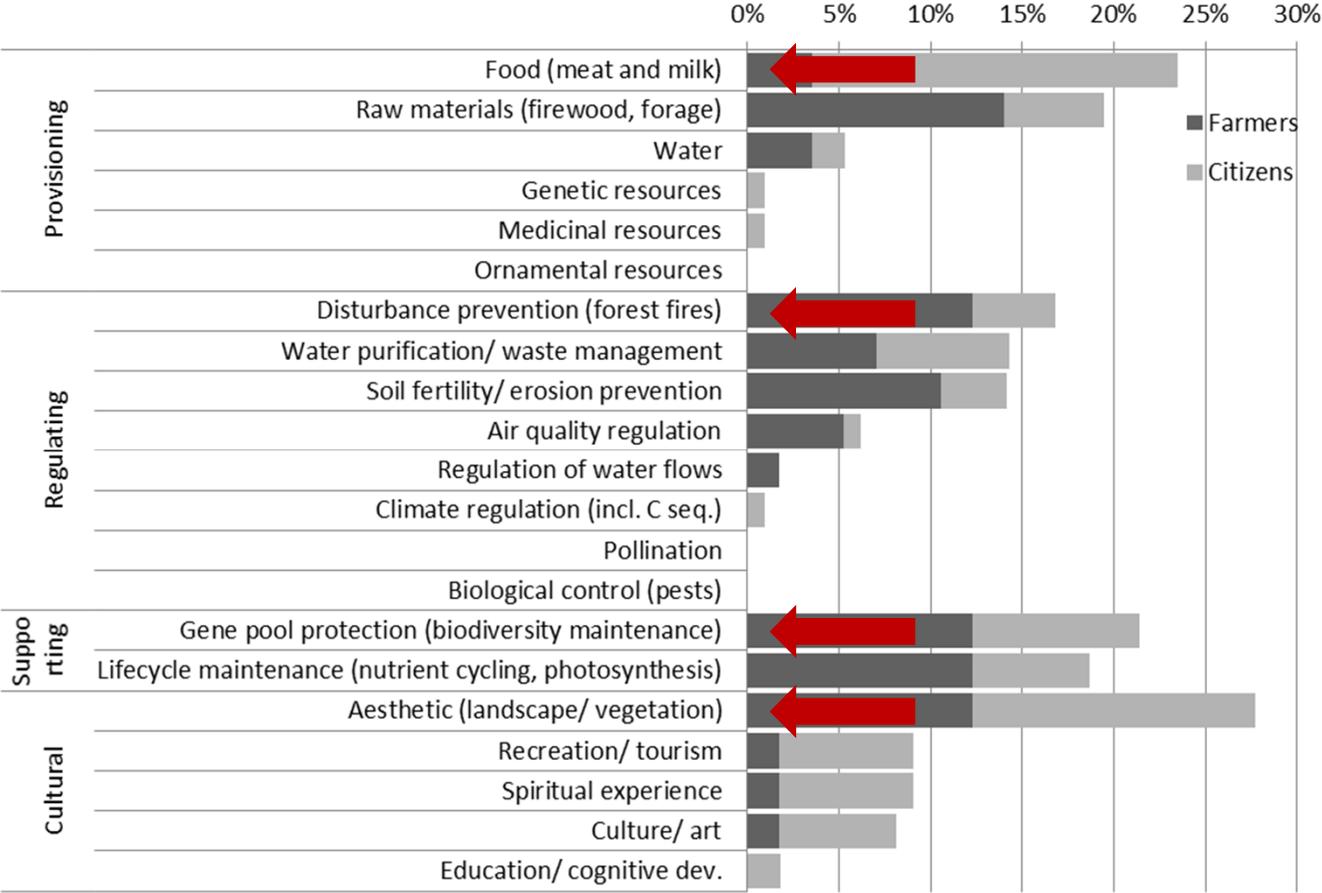
Socio-cultural valuation:



Deliberative techniques, e.g. focus groups

1. Do you know the term “ecosystem services”? (Other words for the term, examples)
2. How do you think livestock production affects the environment and vice versa?
3. How these relationships between livestock production and the environment affect you?
4. What geographical areas/ places can you identify that show the effect of livestock on the environment?
5. Do you agree society needs to pay the delivery of environmental services? Who? In what way?

Ecosystem Services valuation: Mediterranean





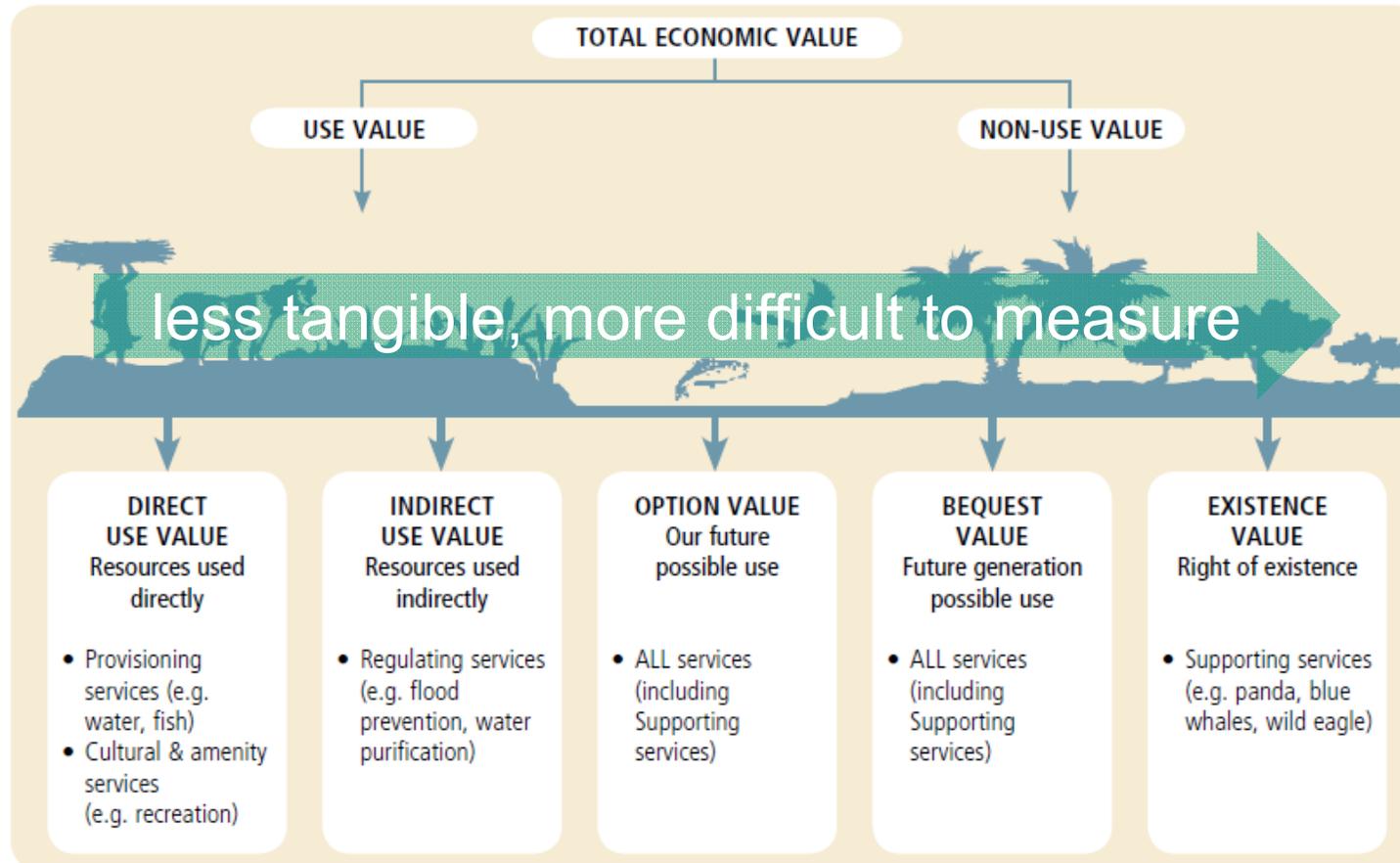
Economic valuation:

but... how do we measure non-market goods?

Total economic value (TEV): sum of output values (the values generated in the current state of the ecosystem, e.g., food production, climate regulation and recreational value) as well as insurance values, now and in the future.



Total Economic Value (TEV)





Non-use value

- do not involve direct or indirect use of the ecosystem service, but reflect the satisfaction that individuals derive from the knowledge they exist (e.g. enjoyment of a beautiful landscape)
- related to moral, religious or aesthetic properties of individuals
- **markets do not exist**

Stated preference methods

- **Choice modelling** Individuals are asked to choose their preferred alternative among several hypothetical land uses. Each scenario of land use is described by a number of attributes (e.g. vegetation cover, landscape fragmentation, biodiversity index, human activities, etc.). Individuals make trade-offs between the levels of the attributes describing the different alternatives in a choice set.
- **Underlying rational decision process**

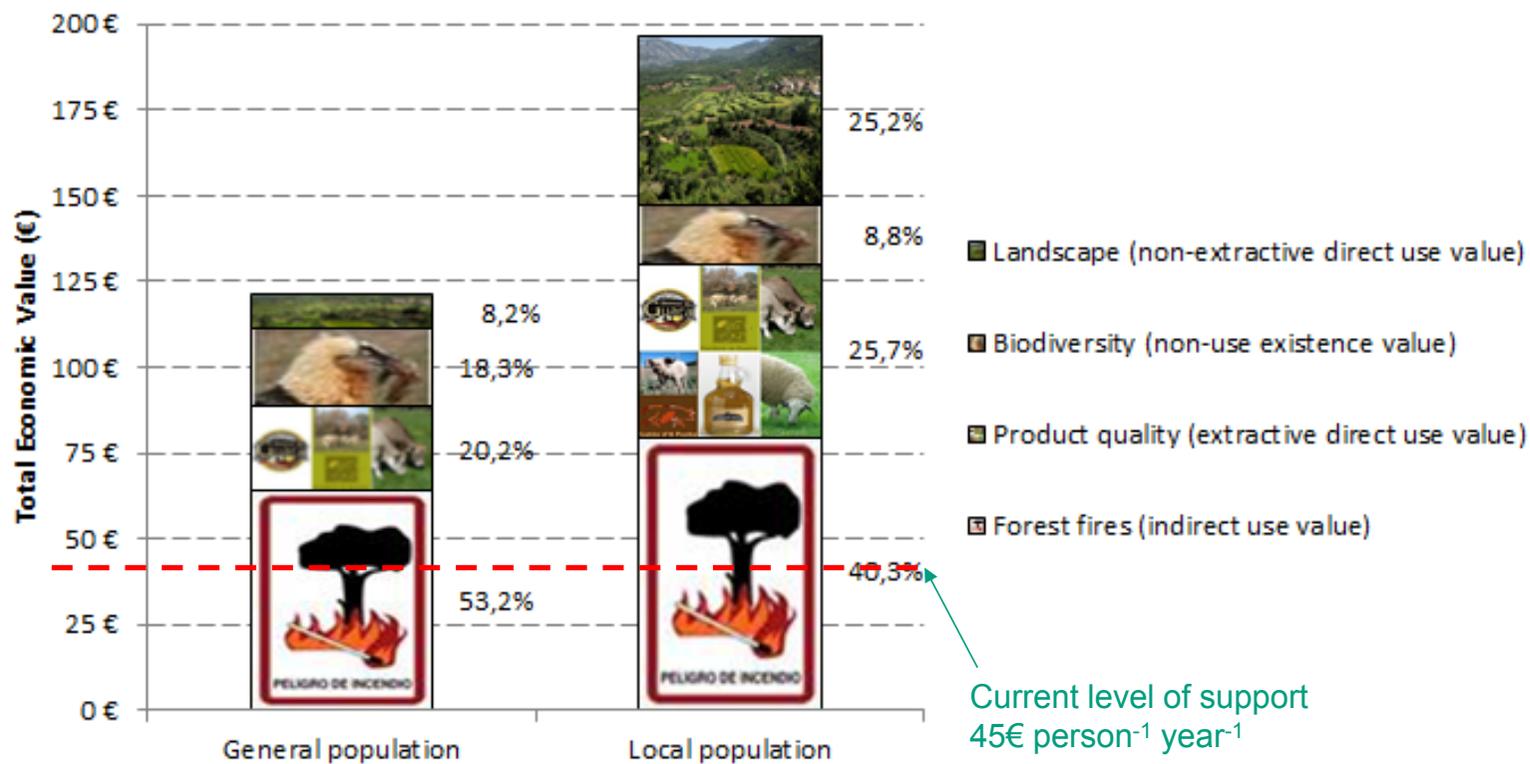
Ecosystem Services valuation: choice model



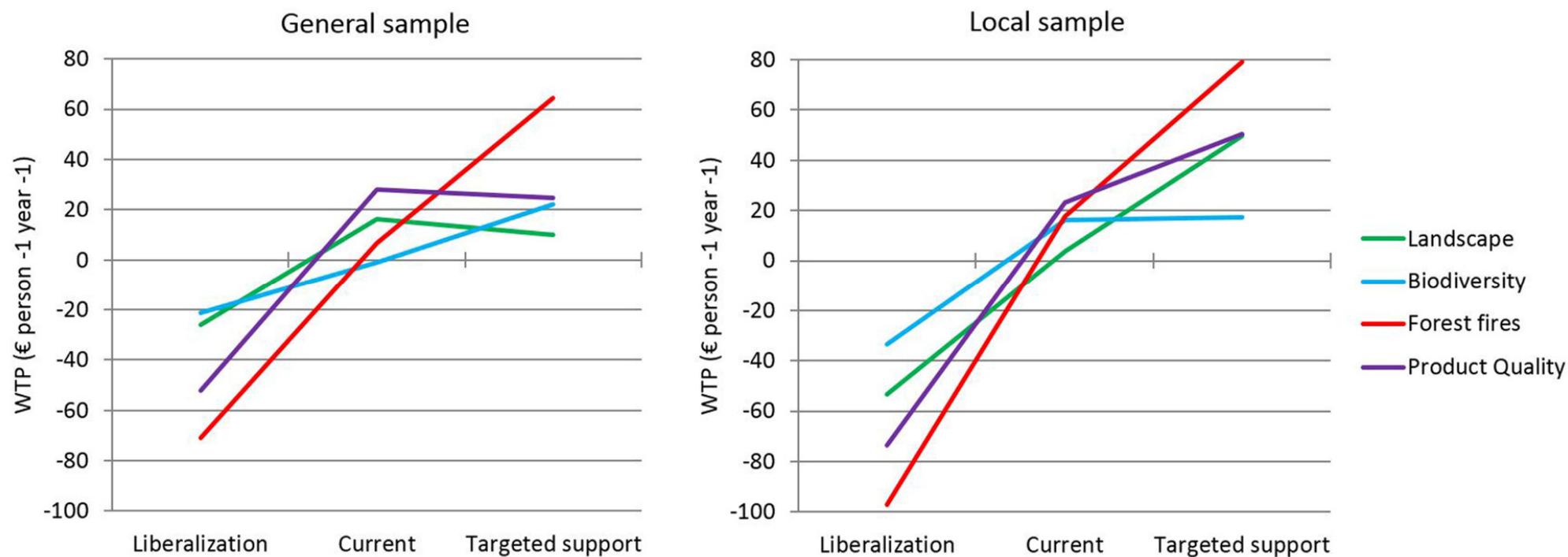
	<u>Policy A</u>	<u>Policy B</u>	<u>CURRENT policy</u>
Landscape	 strong increment of bushes reduction of meadows and crops	 light decrement of bushes light increment of meadows and crops	 light increment of bushes meadows and crops are maintained
Bearded vulture	 7 pairs	 15 pairs	 11 pairs
Forest fires	 6 forest fires per year	 2 forest fires per year	 4 forest fires per year
Product quality linked to territory	 2 quality products available sheep cheese and lamb meat	 6 quality products available sheep cheese, lamb meat, pasture pork meat and olive oil, pasture beef and organic lamb	 4 quality products available sheep cheese, lamb meat, pasture pork meat and olive oil
Annual cost	 15 €	 75 €	 45 €
CHOICE	<input type="radio"/> A	<input type="radio"/> B	<input type="radio"/> C

Example of ES quantification: economic

Total Economic Value (TEV) (€ person⁻¹ year⁻¹)



Willingness to Pay (WTP) (€ person⁻¹ year⁻¹) for ecosystem services in different policy scenarios



Thank you!



Choice modelling



1. Experiment design

- choice alternatives defined with relevant attributes and levels
- efficient design for optimal performance

2. Survey and questionnaire

- local population (face-to-face interview)
- general population (web panel)

3. Analysis

- random parameter logit

Bernués A., Rodríguez-Ortega T., Ripoll-Bosch R., Alfnes R., 2014. **Socio-cultural and economic valuation of ecosystem services provided by Mediterranean mountain agroecosystems.** PLoS ONE 9(7): e102479. <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0102479>

Table 2. Mixed Logit model results for the general and local samples

Parameter	General sample				Local sample			
	Estimate	Standard Error	t Value	Approx Pr > t	Estimate	Standard Error	t Value	Approx Pr > t
Landsc. rich mosaic	0.3982	0.2171	1.83	0.0666	0.7428	0.2765	2.69	0.0072
Landsc. abandonment	-1.0471	0.3066	-3.41	0.0006	-0.7978	0.2873	-2.78	0.0055
Biodiversity 15	0.8877	0.3069	2.89	0.0038	0.2609	0.2144	1.22	0.2237
Biodiversity 7	-0.8434	0.2947	-2.86	0.0042	-0.5034	0.2406	-2.09	0.0364
Forest fires 6	-2.8342	0.9871	-2.87	0.0041	-1.4563	0.5573	-2.61	0.0090
Forest fires 2	2.5707	0.8265	3.11	0.0019	1.1894	0.3797	3.13	0.0017
Prod. quality 6	0.9789	0.4158	2.35	0.0186	0.7589	0.3405	2.23	0.0258
Prod. quality 2	-2.0904	0.7382	-2.83	0.0046	-1.1044	0.4721	-2.34	0.0193
Annual cost	-0.0399	0.0121	-3.30	0.0010	-0.0150	0.0082	-1.81	0.0697
Model fit								
No. respondents	402				102			
No. obs.	2010				510			
Log likelihood	-1892				-480.36			
McFadden LRI	0.1434				0.1427			

Table 3. Willingness to Pay (WTP) (€ person⁻¹ year⁻¹) and composition of the Total Economic Value (TEV)

ES	Value component of TEV	General sample			Local sample		
		WTP	%	Rank	WTP	%	Rank
Landscapes	Non-extractive direct use	10.0	8.2	4	49.5	25.2	3
Biodiversity	Non-use existence	22.2	18.3	3	17.4	8.8	4
Forest fires	Indirect use	64.4	53.2	1	79.3	40.3	1
Product Quality	Extractive direct use	24.5	20.2	2	50.6	25.7	2
TEV		121.2	100.0		196.8	100.0	

Scenario	Landscape	Biodiversity	Forest fires	P. Quality	Cost
<p>Current policy. The reference scenario assumes that European agricultural policy for rural development (Pillar 2) funds, in particular Axe 2 related to land management, remain stable. In this scenario, the number of farms and animals remains the same, and grazing management and other agricultural practices are also stable. Farms are very diverse in terms of intensification level, land use (and dependence on natural resources) and grazing management (e.g., grazing season varied between 180 and 326 days) [14]. However, current agri-environmental measures are implemented regardless of the real grazing management of the farm. As mentioned in the main text, current grazing pressure modulates but is not enough to stop the encroachment of shrub vegetation [3].</p>	<p>A real picture (2011) of Almunias de Rodellar village and its surroundings is presented.</p>	<p>There are 11 pairs of bearded vultures, and the population is considered stable in this scenario [6].</p>	<p>Under this scenario the risk of forest fires and therefore the number of events remains moderate, at in 4 forest fires per year (average annual number of fire events in the period 1974-1997)</p>	<p>The number of quality products available to consumers in the park is 4, corresponding to private brands for: sheep cheese, lamb meat, pasture pork meat and olive oil.</p>	<p>The yearly budget of the RDP of Aragón (2007-2013) in the Axe 2 (Improvement of the Environment) was divided by the number of inhabitants above 18, resulting in a cost of 45.5€ per person per year.</p>
<p>Liberalization of policy. This hypothetical scenario depicts the ‘liberalization’ of agricultural policy, and therefore assumes a reduction of support in the form of both EU and national agri-environmental measures. Therefore, there is a process of reduction of agriculture, or even abandonment of agriculture in some areas. It is very difficult to forecast the evolution of the agricultural sector in the area of study with a scenario of drastic reduction of subsidies. According to data from Pardos et al. [15], 66% of sheep farms in a representative sample in the region obtain a negative Gross Margin before premiums. We have assumed that the decrease of Common Agricultural Policy premiums would cause a decrease in animals and farms, especially those with already uncertain continuity prospects (38% of farms in the PNSCG) that have a grazing management regime considered more beneficial for conservation of the park [14]. Some of the remaining farms could develop more “extensive” grazing management to reduce costs; however, grazing pressure diminishes considerably and large pastoral areas are abandoned in the near future under this scenario.</p>	<p>An alternative picture is presented showing more marginal areas abandoned and shrub and forest vegetation increases. Cultivation is reduced, and grazing-only meadows predominate. The landscape structure is more homogeneous (reduction in the number and types of patches).</p>	<p>Margalida et al. [5] estimated that the decline in the population of bearded vultures in a similar area caused by reduction of biomass from domestic animals would mean that the species decrease drastically (from 16 to 6 pairs) and would not recover.</p>	<p>The surface affected by forest fires in a no-intervention scenario increases 313.5% [16]. Vicente-Serrano et al. [8] indicated an increase of fire risk of 27.1% between 1957 and 2000 because of agricultural abandonment and lack of livestock grazing. We considered that the number of fire events increases by 50%, i.e., 6 fires per year.</p>	<p>The number of quality products available to consumers decreases to 2 as a consequence of the reduction of support.</p>	<p>The specific policies for maintaining/ improving ecosystem services in this alternative have a much lower budget, and therefore the societal cost per person decreases to 15€ per year.</p>
<p>Targeted support. This scenario involves the greening of the Common Agricultural Policy through the more targeted support of agri-environmental schemes, which would have a positive effect on biodiversity and on the ES derived from agriculture; this impact can be attributed to an increase in extensively managed grasslands. There are supplementary payments in areas of disadvantage or natural handicap, and the Pillar 2 budget increases. Most measures are specifically designed and targeted to the delivery of public goods, and concrete targets are established so that agri-environmental measures become Payments for Ecosystems Services, in which farmers are compensated for the ES they deliver. As a consequence, even if the total number of farms and animals does not vary under this scenario, land use is modified (recovery of some previously abandoned areas, recovery of agricultural and forage crops, mowing meadows) and grazing management is targeted towards the provision of ecosystem services, i.e., more animals are grazing for longer periods of time, covering key areas where grazing was abandoned in the past.</p>	<p>An alternative picture shows a situation where some abandoned areas are cultivated again and land use is more diversified (different agricultural crops, e.g., cereals, trees; mowing meadows and forage crops, e.g., hay bales). The landscape structure is diversified (increase in the number and types of patches), emulating a rich mosaic.</p>	<p>The population of bearded vultures might not increase considerably in the PNSCG even if more feed was available, as this species is close to the carrying capacity [6]. However, we have considered that the population can still grow to 15 pairs to reflect the fact that some pairs can colonize suitable neighbouring areas [17].</p>	<p>Tous de Sousa [16] indicated that the surface affected by forest fires in an optimal intervention scenario decreases by 71.5%. We considered that the number of fire events decreases by 50%, i.e., 2 fires per year.</p>	<p>The number of quality products available to consumers increases to 6, including pasture beef and organic lamb.</p>	<p>The specific policies for maintaining/ improving ecosystem services in this alternative have a larger budget, and so the societal cost per person increases to 75€ per year.</p>





