

A large flock of sheep and goats is moving up a steep, rocky hillside. The animals are densely packed, filling the lower and middle portions of the frame. The terrain is rugged with reddish-brown rocks and sparse vegetation. In the upper part of the image, two people are visible walking along a path at the top of the slope. The overall scene depicts a traditional transhumance practice in a mountainous landscape.

Valuation and payment for ecosystem services of sheep and goats

Alberto Bernués
abernues@aragon.es

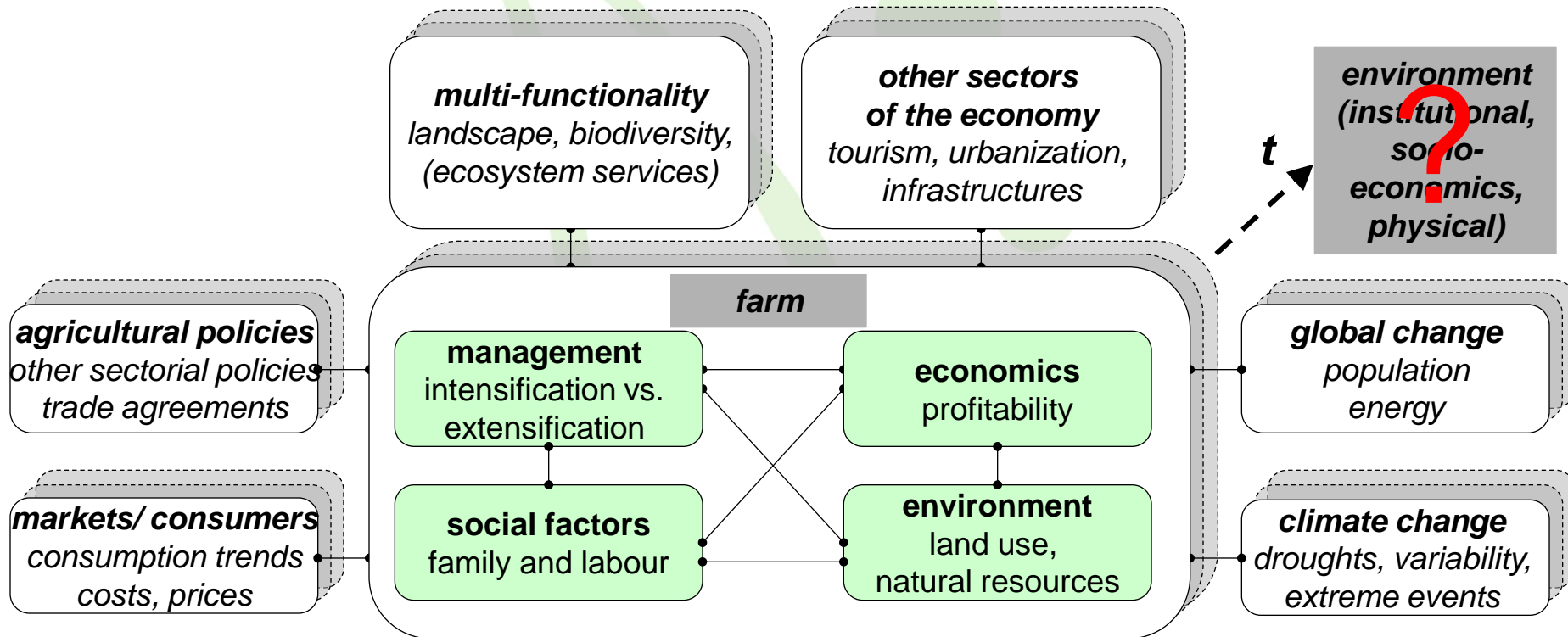
Outline

1. Introduction
2. Valuation of ecosystem services
3. Payments for ecosystem services
4. Wrap up

1. Introduction



Conceptual framework to study sustainability of agro-ecosystems



Livestock – environment

- negative impacts

- emission of greenhouse gases (CO_2 , CH_4 , N_2O) and ammonia
- land degradation and deforestation
- pollution of soils and water
- biodiversity loss

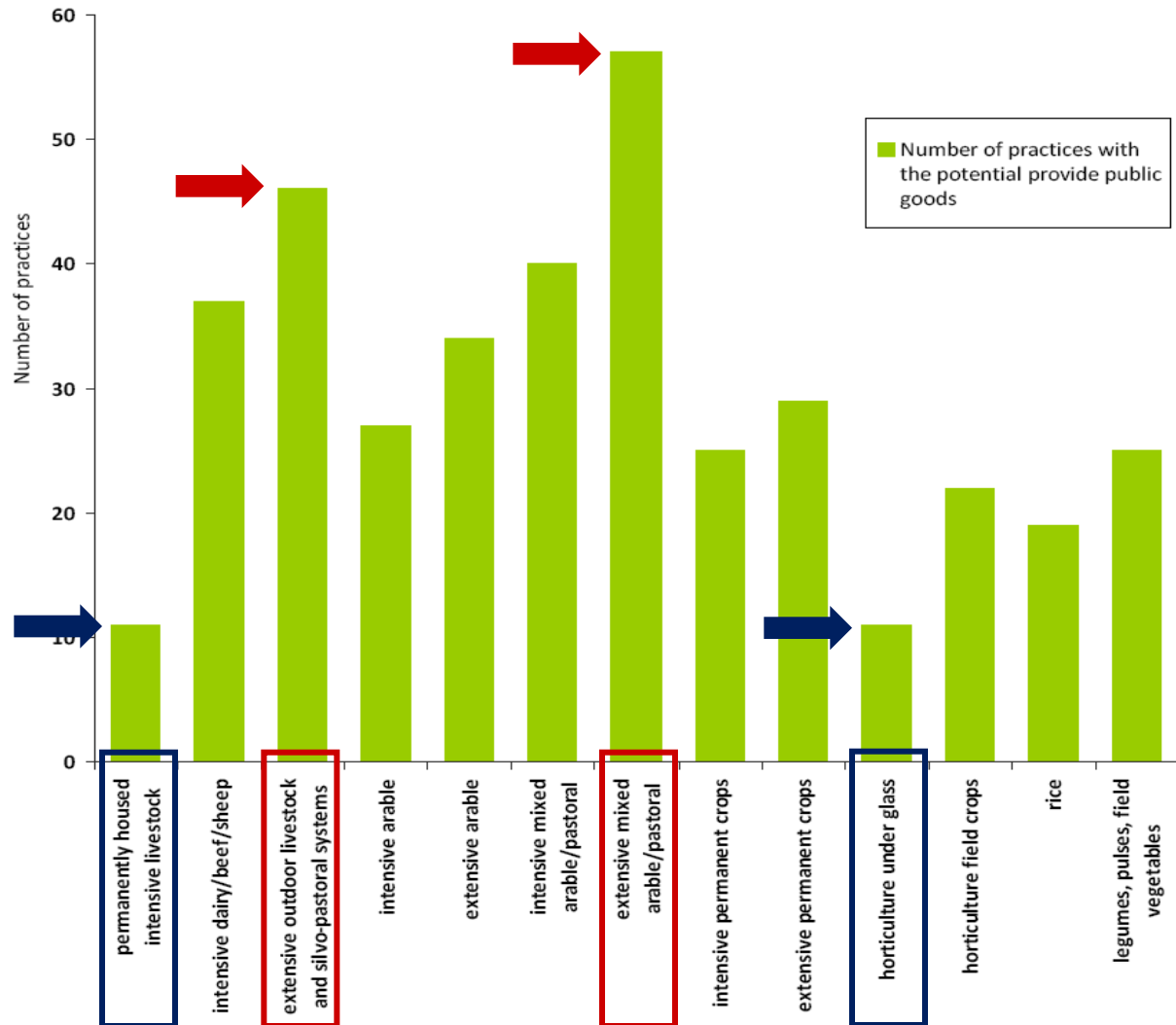
- positive impacts

- extensive systems (low-input): landscape and biodiversity conservation
- prevention/ regulation of environmental hazards (forest fires, erosion, desertification)
- storage of carbon in grasslands (34%, forests 39%)

livestock's long shadow
environmental issues and options



Different farming systems render different ecosystem services/ public goods



Provision of Public Goods
through Agriculture
in the European Union

Tamsin Cooper
Kaley Hart
David Baldock



Diversity of farming systems

Specialized sheep-mountain pastures

Fully-integrated mixed sheep-permanent crops

Partially-integrated mixed sheep-arable crops

Harvest (kg DM)

8.922

68.738

373.592

Self-consumption (%)

100

100

35

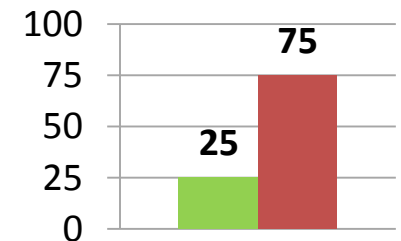
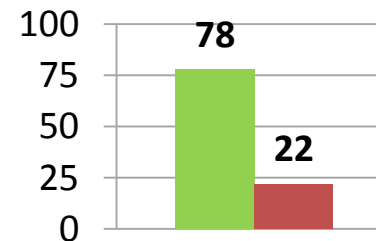
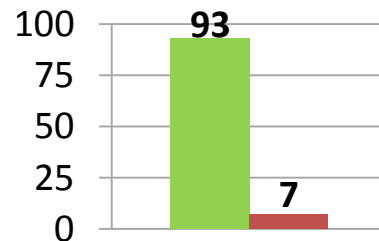
Sales (%)

0

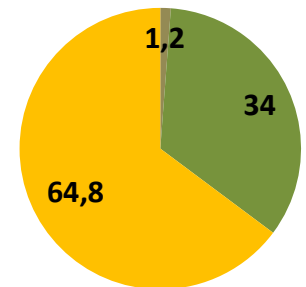
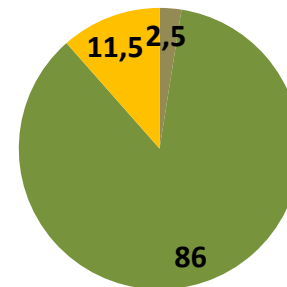
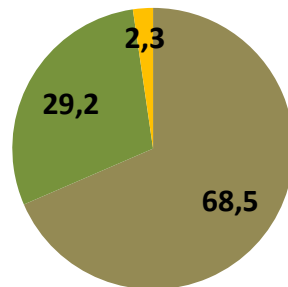
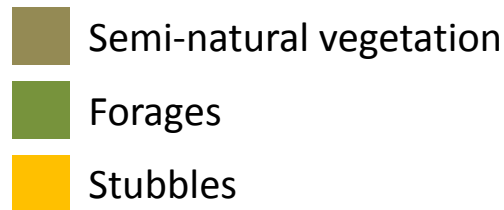
0

65

Grazing/Indoor (%)



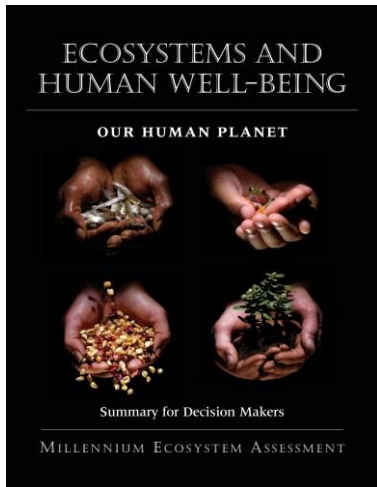
Annual grazing (%)



2. Valuation of ecosystem services

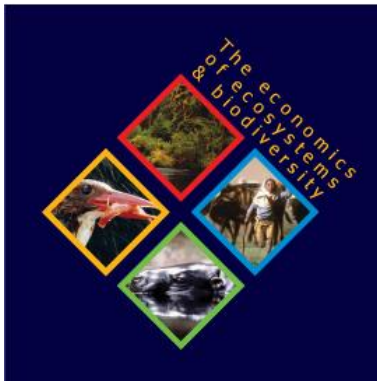


Ecosystem services



Ecosystem services are the direct and indirect benefits people obtain from ecosystems

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





Main ES derived from pasture-based livestock systems



1. **Provisioning**: quality products linked to the territory
2. **Regulating**: prevention of forest fires (Euro-mediterranean basin) soil fertility (Nordic regions), etc.
3. **Supporting**: biodiversity conservation
4. **Cultural**: agricultural landscapes

Ecosystem services & biodiversity

...what is the role of Biodiversity?

- For ecologists, provision of ecosystem services is directly related to biodiversity
- Biodiversity underpins ecosystem integrity or ecosystem state
- Increasing biodiversity also benefits the variety of ecosystem services available to society

Drivers of biodiversity loss in Europe

EEA, 2004. **High Nature Value Farmland: characteristics, trends and policy challenges.** European Environmental Agency.



Marginalization/
abandonment of
HNVF

Intensification/
specialization
of agriculture

Biodiversity conservation
Provision of public goods

greater
biodiversity
index



HNVF



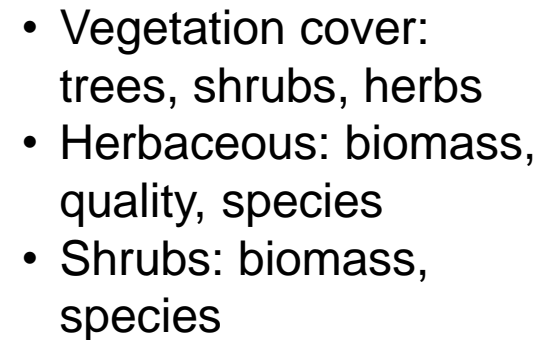
semi-
natural
grassland



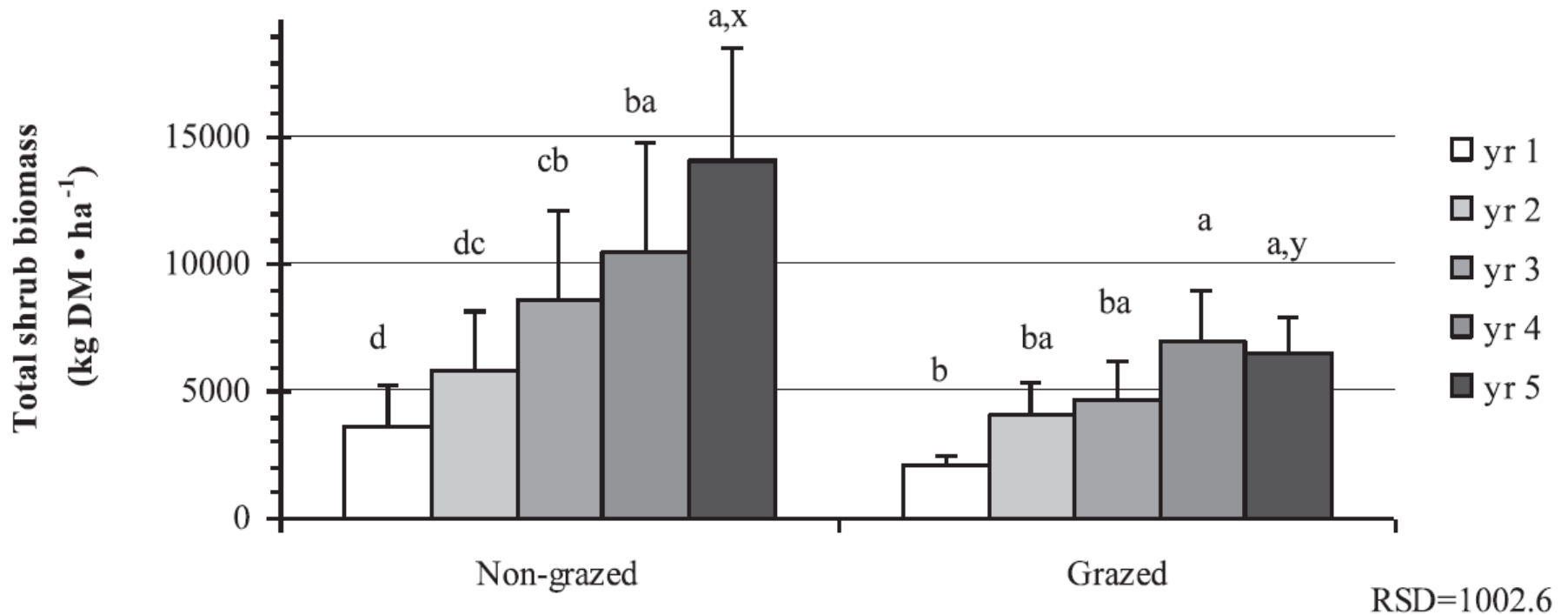
Ecosystem Services valuation

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

1. BIOPHYSICAL
2. SOCIO-CULTURAL
3. ECONOMIC



Evolution of shrub vegetation in Guara





effect of grazing on landscape: current situation



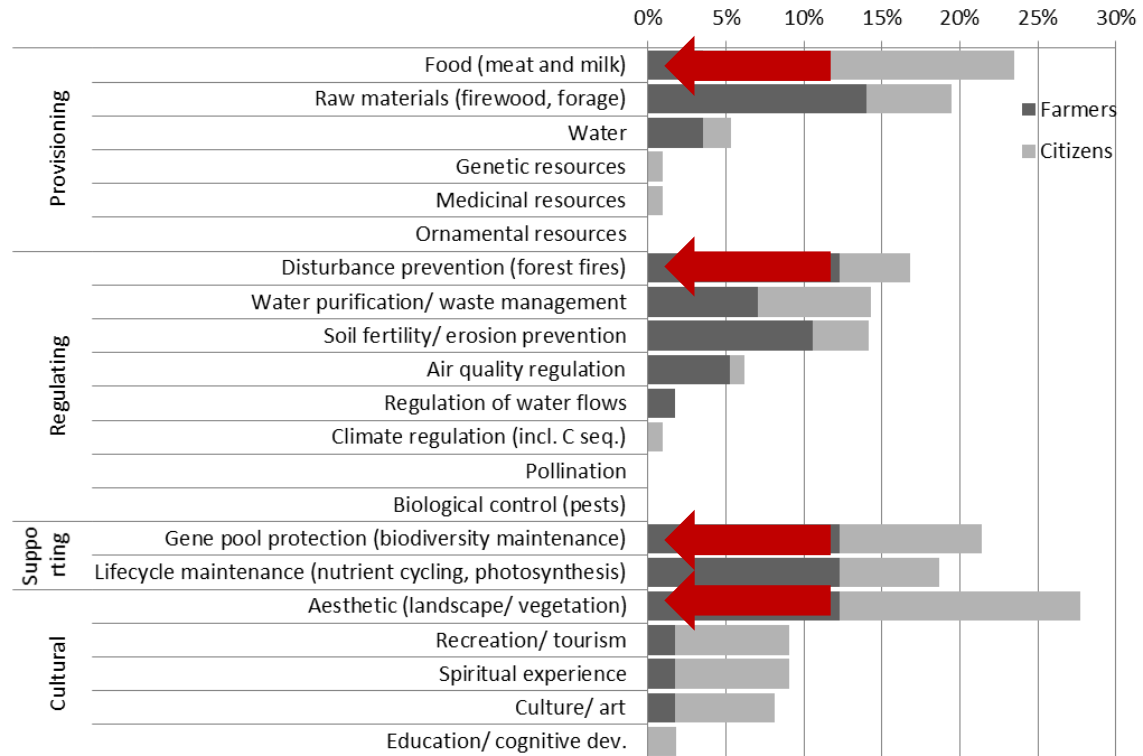
effect of grazing on landscape: abandonment



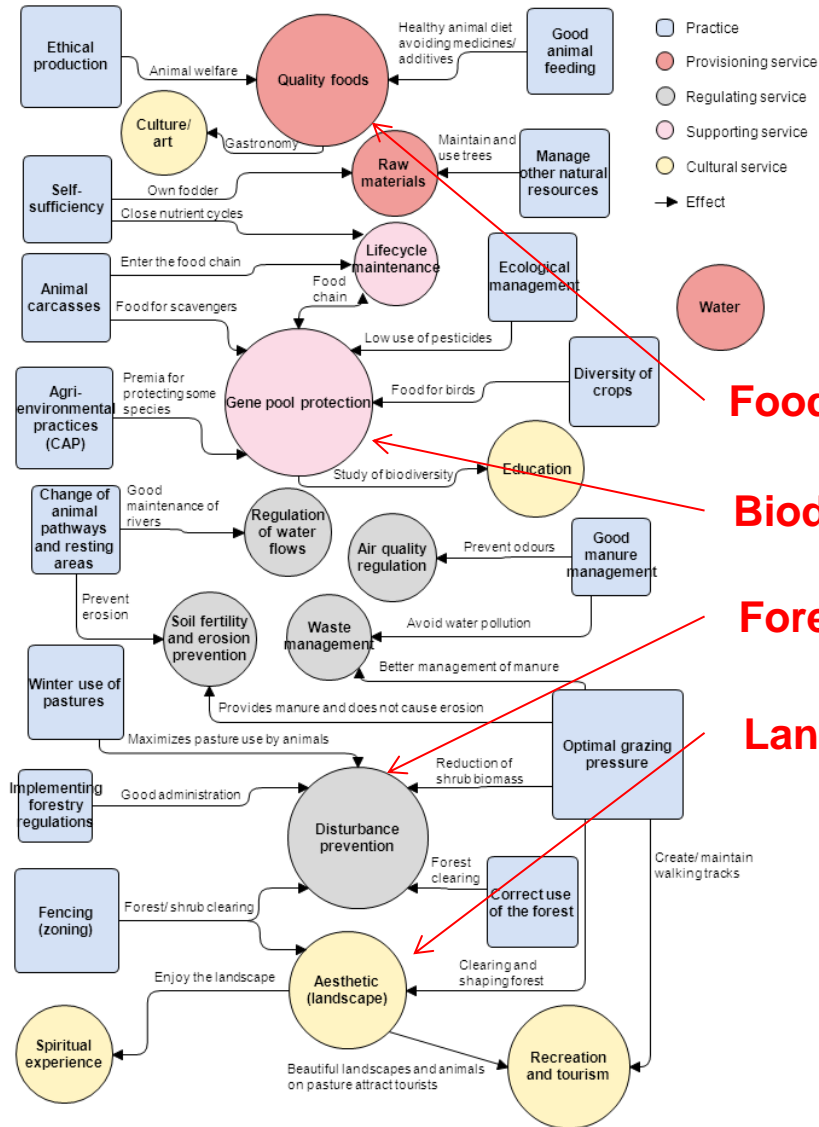
effect of grazing on landscape: optimal



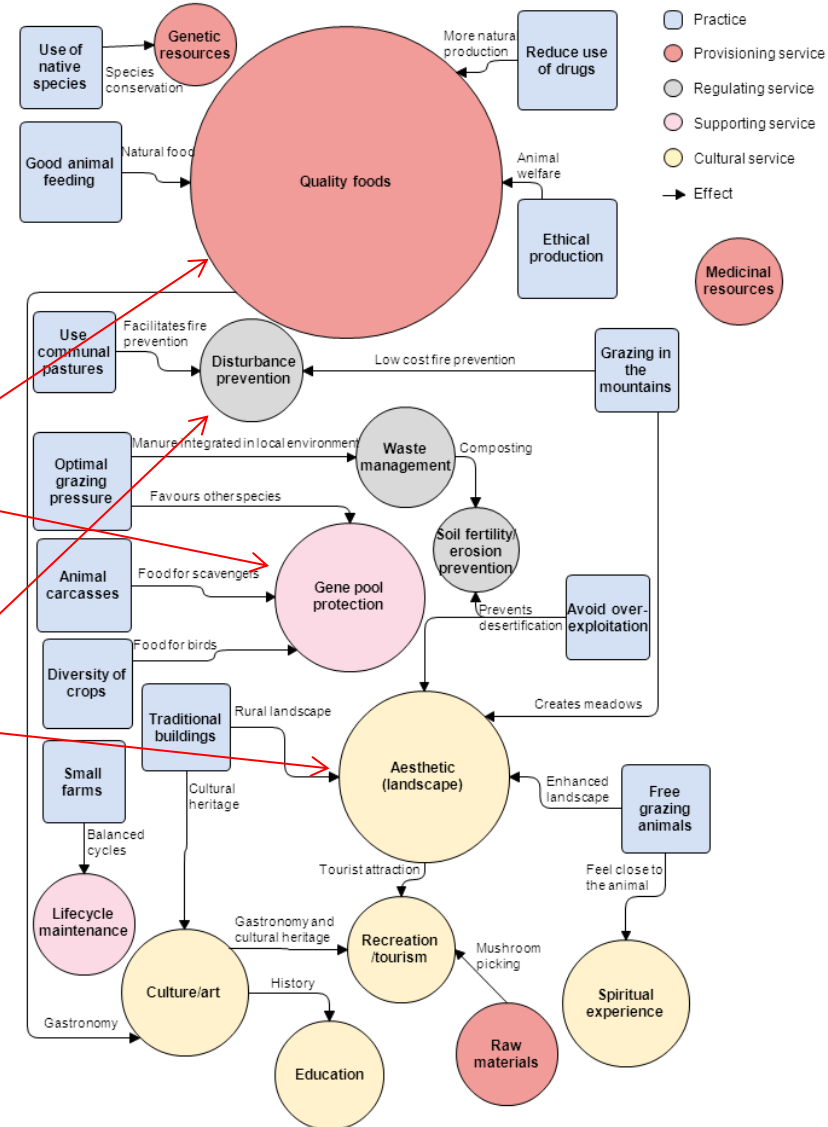
Socio-cultural valuation: views of farmers and other citizens



farmers



other citizens

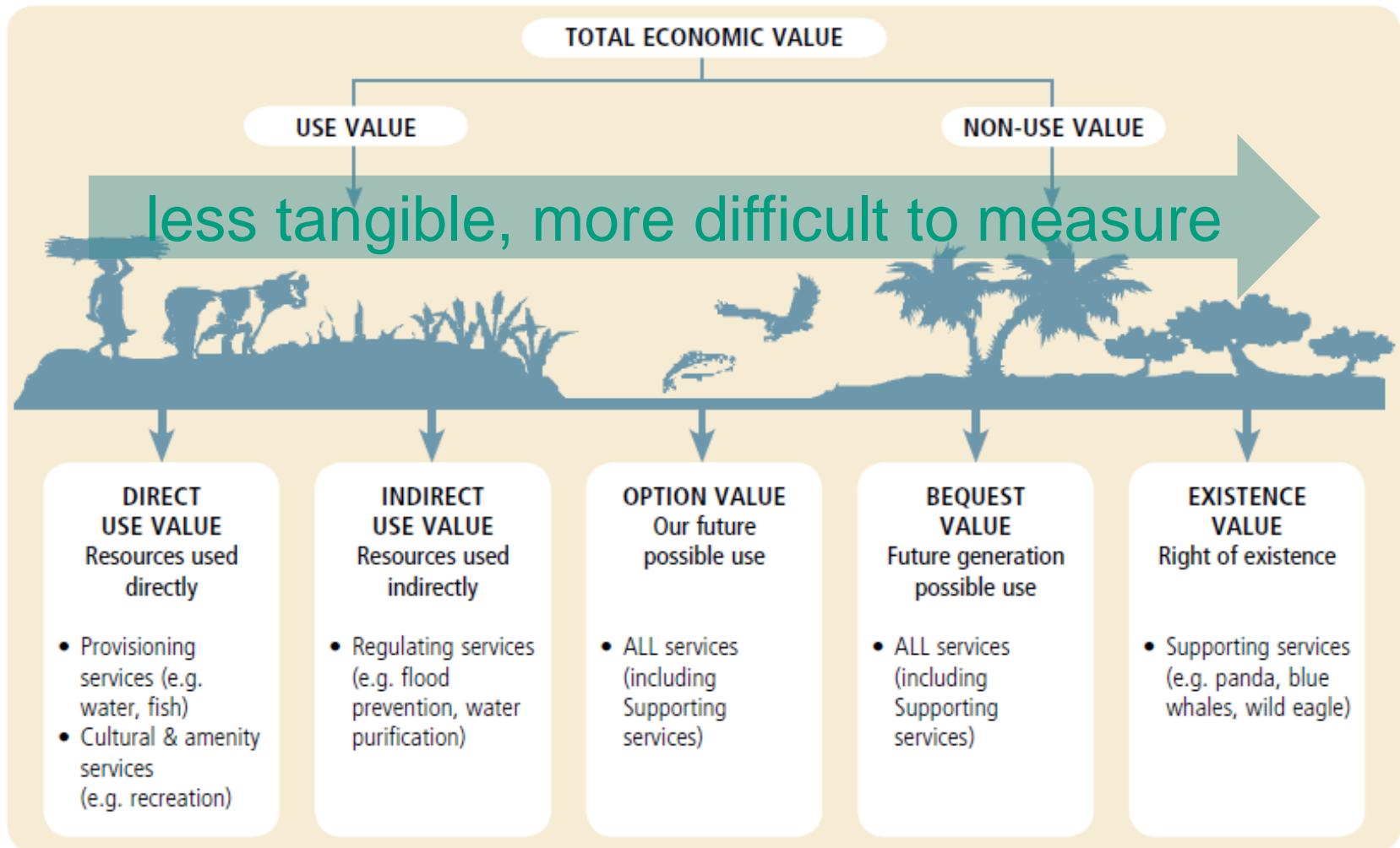


Economic valuation: measuring public goods?

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**

Scenarios in Guara N.P.

Current scenario


















Liberalization scenario



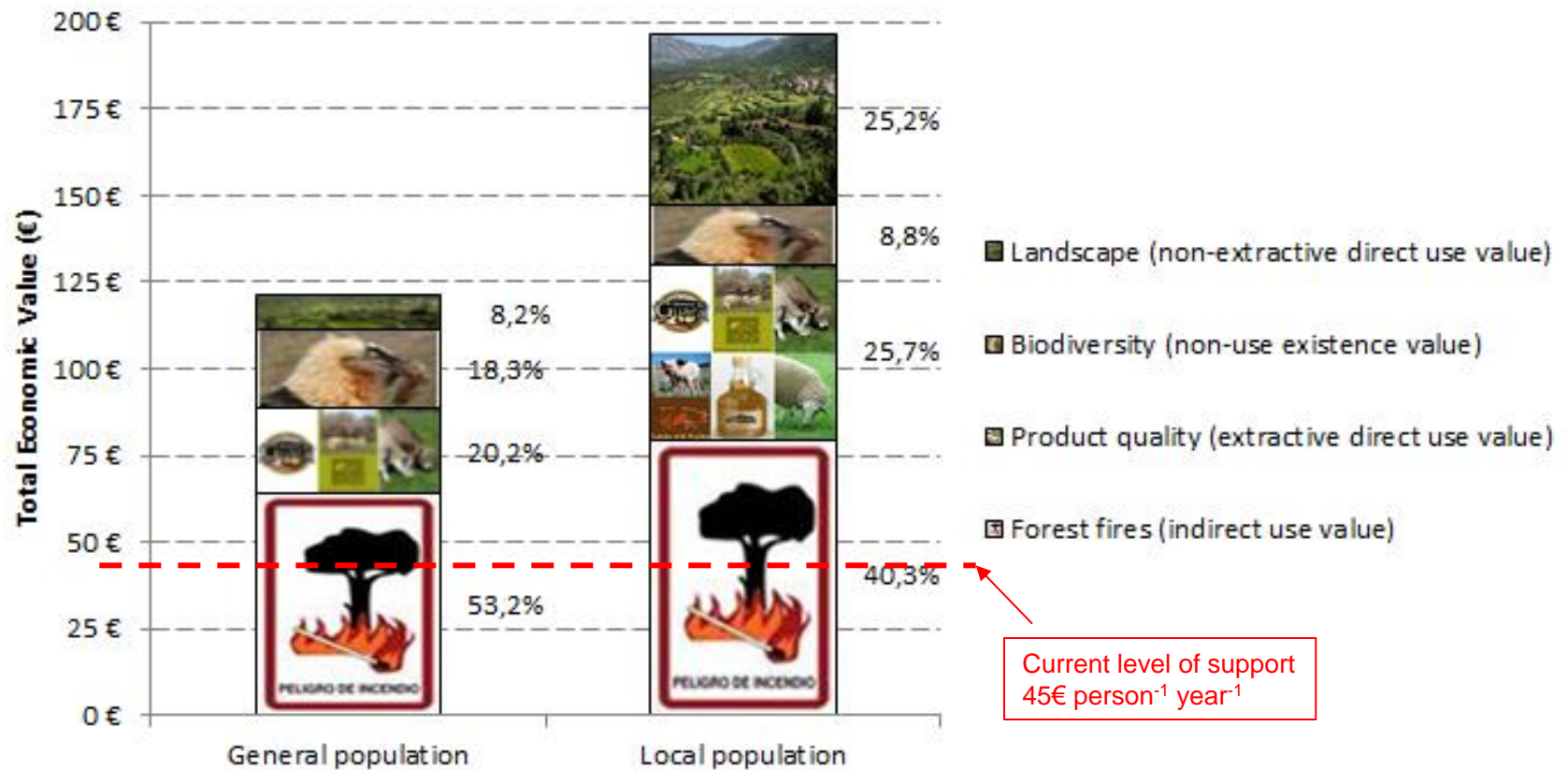
Targeted support scenario

Choice model for ES in Guara

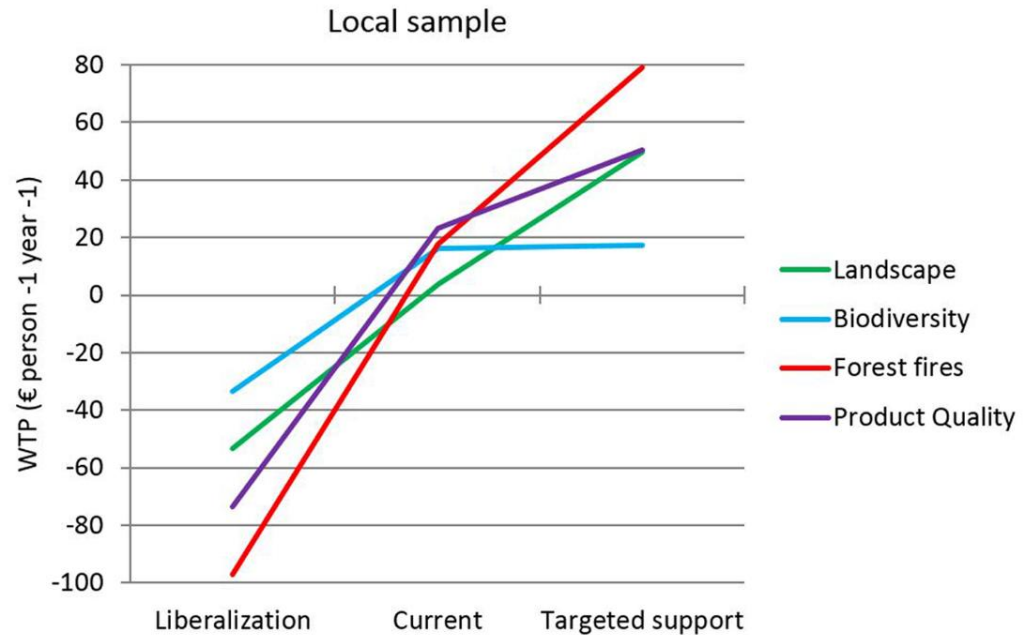
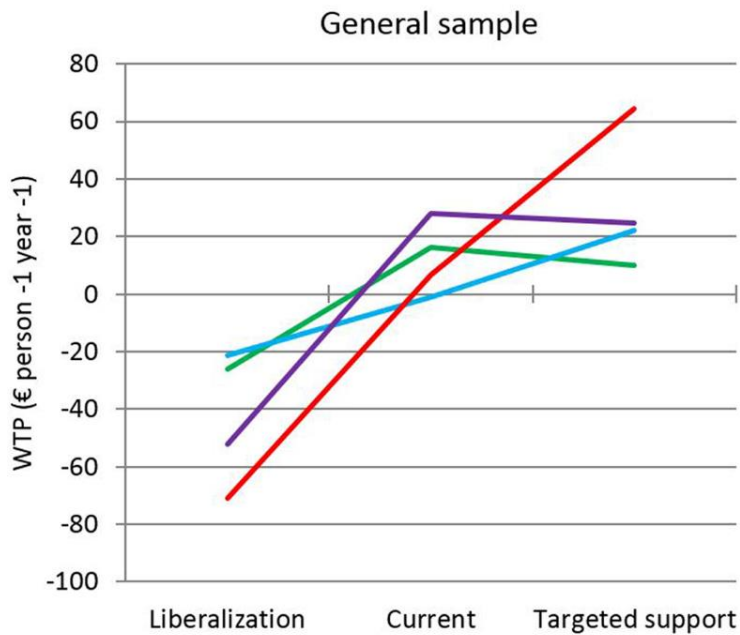
	<u>Policy A</u>	<u>Policy B</u>	<u>CURRENT policy</u>
Landscape	 <p>strong increment of bushes reduction of meadows and crops</p>	 <p>light decrement of bushes light increment of meadows and crops</p>	 <p>light increment of bushes meadows and crops are maintained</p>
Bearded vulture	 <p>7 pairs</p>	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

Economic value of agro-ecosystems in Guara

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



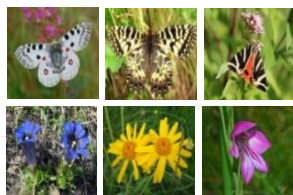
Willingness to Pay (WTP) (€ person⁻¹ year⁻¹) for ecosystem services in different policy scenarios



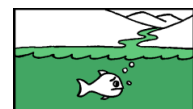
Blocco 1 Scheda 2

Politica A

Mantenimento dei pascoli alti e possibile incremento delle malghe. Aumento dei prati sfalciati nel fondovalle.



Aumento
del
numero di
specie



Fiumi e laghi
leggermente
inquinati



9
formaggi

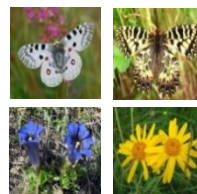
(5 di valle, 3 di malga,
1 DOP)



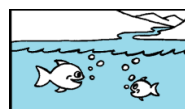
30 euro

Politica B

Abbandono delle malghe e rimboschimento dei pascoli alti. Concentrazione delle aziende zootecniche e/o agricole nel fondovalle (conversione a seminativi dei prati sfalciati)



Leggera
diminuzion
e del
numero di
specie



Fiumi e laghi non
inquinati



13
formaggi

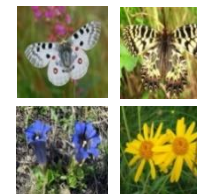
(7 di valle, 4 di
malga, 2 DOP)



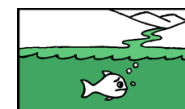
40 euro

Politica ATTUALE

Aumento di arbusti e erbe infestanti nei pascoli e riduzione nell'uso delle malghe. Diminuzione dei prati sfalciati e tendenza alla concentrazione delle aziende zootecniche e/o agricole nel fondovalle



Leggera
diminuzion
e del
numero di
specie



Fiumi e laghi
leggermente
inquinati



13
formaggi

(7 di valle, 4 di
malga, 2 DOP)



30 euro

Paesaggio

Cliccare sopra l'immagine per ingrandire

Biodiversità

Diversità di fiori e farfalle
in pascoli e prati

Qualità dell'acqua

Prodotti di qualità

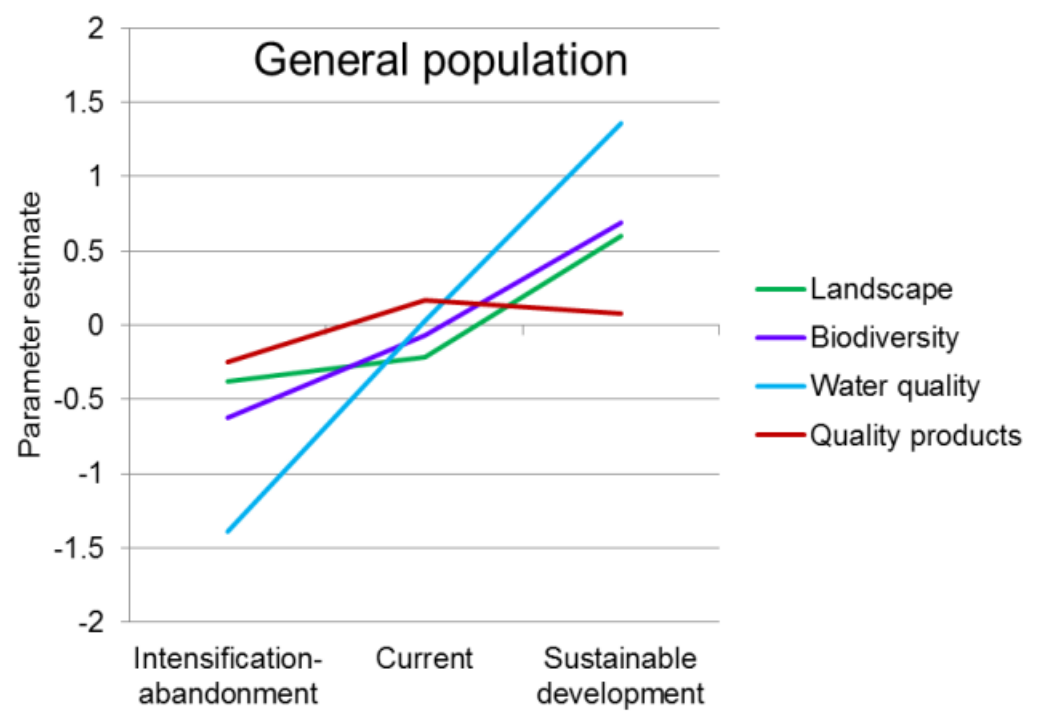
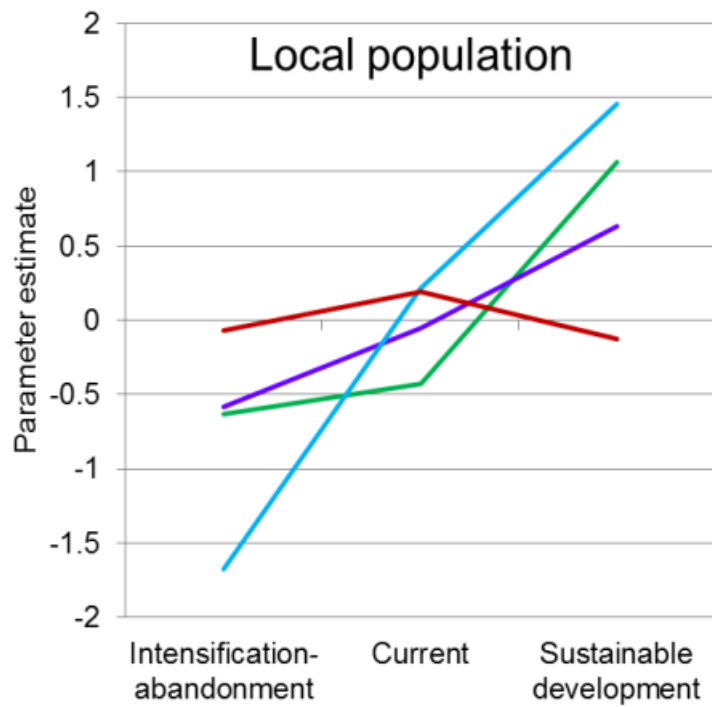
Costo annuale

OPZIONE SCELTA

☐ A

☐ B

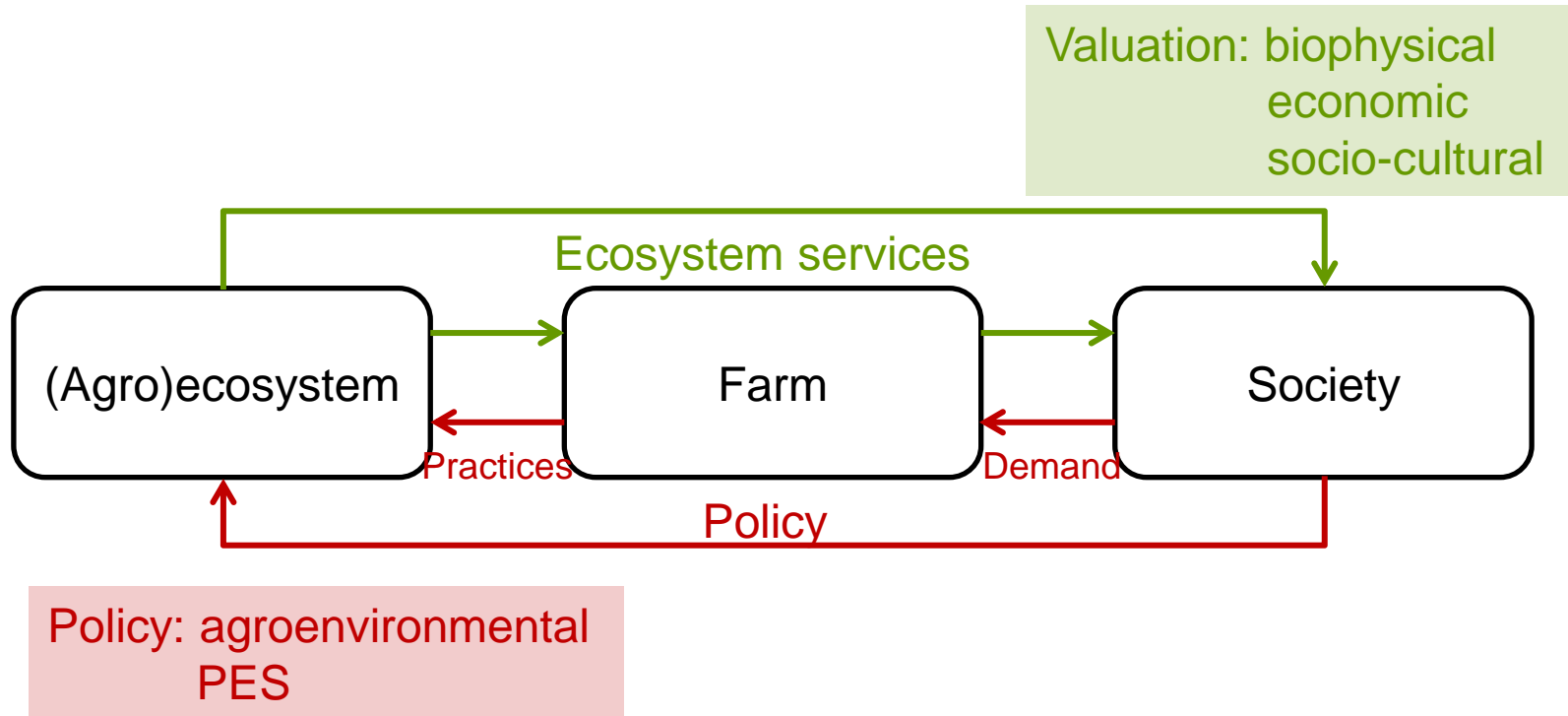
☐ C



3. Payments for ecosystem services



ES framework



Objectives

- Evaluate, according to expert knowledge, the contribution of farming practices to ES in Mediterranean agro-ecosystems
- Design a PES system based on management

Effect of agricultural practices on ES

- Starting point
 - 66 farming practices on relevant ES (EU report)
 - 10 monitored sheep and mixed sheep-crops farms in Aragón (SP)

- Delphi panel

- Questionnaire:

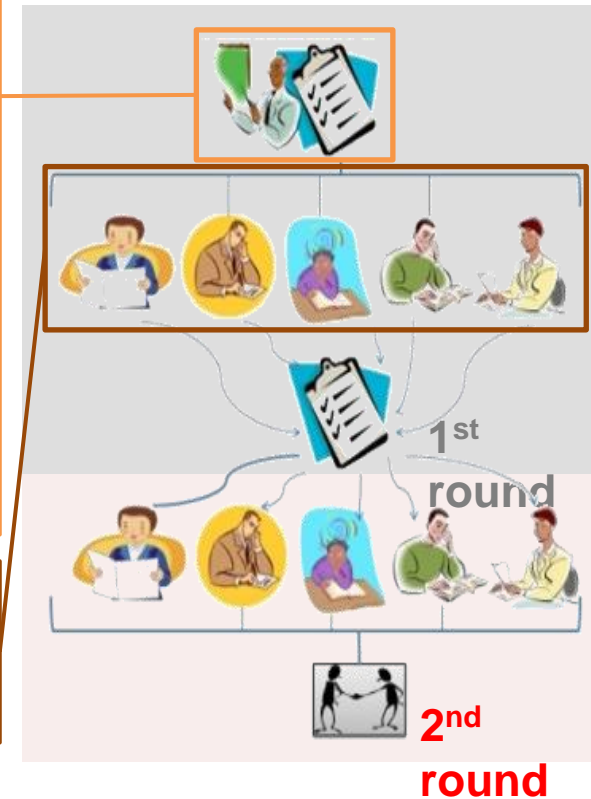
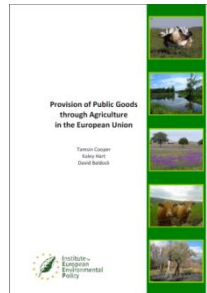
- Description of mountain and semiarid lowlands
Mediterranean agro-ecosystems



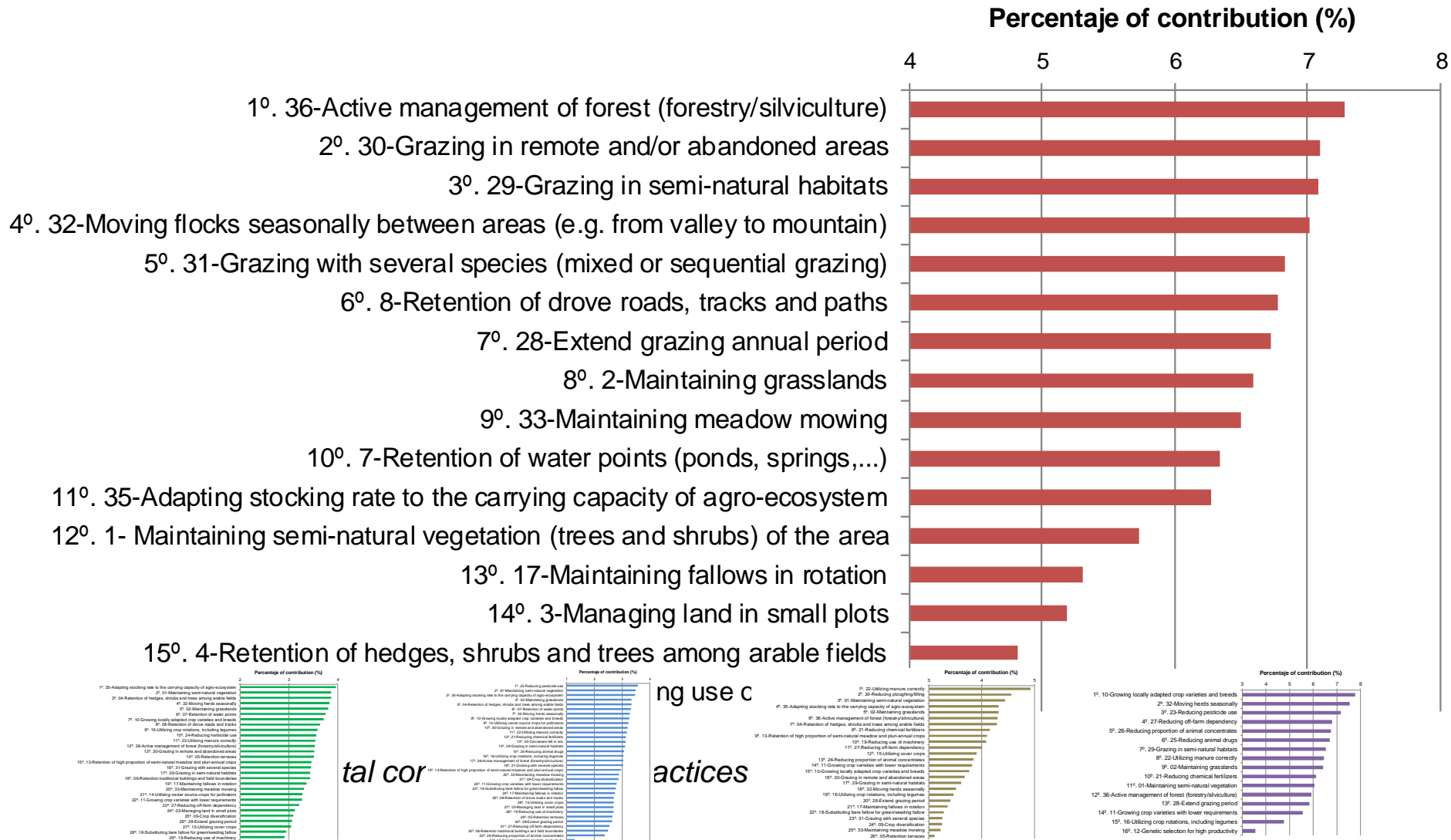
- Personal data and self-appraisal on expert **knowledge** about ES:
1: very low – 5: very high
 - Positive **contribution** of 36 farming practices on **ES**:
0: none, 1: very low – 5: very high; Don't know

- Experts on agriculture – environment (n=61):

- Researchers (n = 29)
 - Technicians/managers (n = 32)



Contribution of farming practices on **wildfires prevention**



Effect of agricultural practices on ES

Ranking	Landscape	Biodiversity	Wildfires	Carbon seq.	Quality prod.
1st	35	23	36	22	10
2nd	1	1	30	20	32
3 th	4	35	29	1	23
4 th	32	2	32	35	27
5 th	2	4	31	2	26
...36 th

FARMING PRACTICES

1 - Maintaining semi-natural vegetation (trees and shrubs) of the area

2 - Maintaining grasslands

4 - Retention of hedges, shrubs and trees among arable fields

10 - Growing locally adapted crop varieties and breeds

20 - Reducing ploughing/tilling

22 - Utilizing manure correctly

23 - Reducing pesticide use

26 - Reducing proportion of animal concentrates

27 - Reducing off-farm dependency (e.g. feed, fertilizers)

29 - Grazing in semi-natural habitats

30 - Grazing in remote and/or abandoned areas

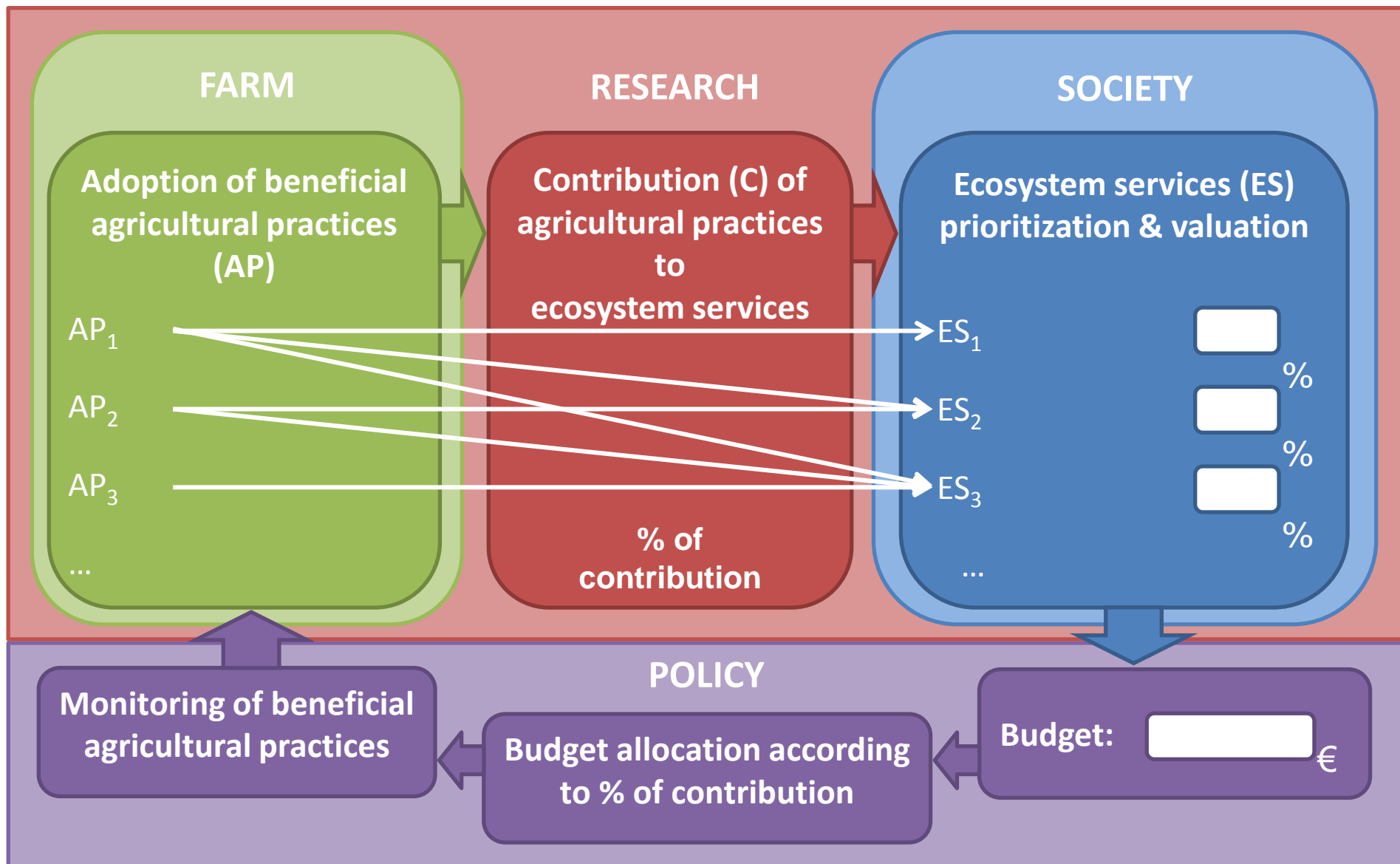
31 - Grazing with several species (mixed or sequential grazing)

32 - Moving flocks seasonally between areas (e.g. from valley to mountain)

35 - Adapting stocking rate to the carrying capacity of agro-ecosystem

36 - Active management of forest (forestry/silviculture)

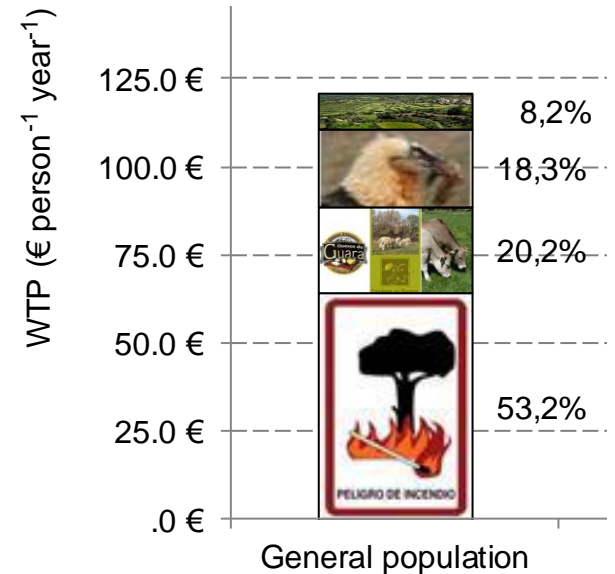
PES design



An example

‘Sierra and Cañones de Guara’ Natural Park

Based on **Preference** of population according to their WTP for ES



Top 5 farming practices

- 1º. Moving flocks seasonally between areas (e.g. from valley to mountains)
- 2º. Grazing in semi-natural habitats
- 3º. Active management of forest (forestry/silviculture)
- 4º. Maintaining grasslands
- 5º. Extend grazing annual period



4. Wrap up



Take-home messages

1. the unit of delivery of ecosystem services is the **agroecosystem**; i.e. the production system, not the species or products
2. animal agriculture can be **multifunctional** (delivery of public goods or ecosystem services), but not all farming systems are (e.g. ecosystem disservices or negative externalities)
3. there is need to objectively value “**non-market**” functions of animal agriculture and integrate public goods into policy

Bibliography

- Rodríguez-Ortega T., Oteros-Rozas E., Ripoll-Bosch R., Tichit M., Martín-López B., Bernués A., 2014. Applying the ecosystem services framework to pasture-based livestock farming systems in Europe. *Animal* 8, 1361-1372.
- 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.
- Bernués A., Tello-García E., Rodríguez-Ortega T., Ripoll-Bosch R., Casasús I. 2016. Agricultural practices, ecosystem services and sustainability in High Nature Value farmland: Unraveling the perceptions of farmers and nonfarmers. *Land Use policy* 59, 130-142.
- Rodríguez-Ortega T., Olaizola A.M., Bernués A., 2018. A novel management-based system of payments for ecosystem services for targeted agri-environmental policy. *Ecosystem Services* 34, 74-84.
- Martín-Collado D., Boetcher P., Bernués A., 2019. Opinion paper: Livestock agroecosystems provide ecosystem services but not their components: the case of species and breeds. *Animal* 13, 2111-2113.
- Bernués A., Alfnes F., Clemetsen M., Eik L.O., Faccioni G., Ramanzin M., Ripoll-bosch R., Rodríguez-Ortega T., Sturaro E., 2019. Exploring social preferences for ecosystem services of multifunctional agriculture across policy scenarios. *Ecosystem Services* 39, 101002.

Thank you!

