A Valuation-Based Approach for Irrigated Agroecosystem Services

J.A. Zabala[1], C. Marín-Miñano[1], J. A. Albaladejo-García[2], E. I. López-Becerra[1], M. D. de Miguel[1], J. M. Martínez-Paz[2], F. Alcon[1]

[1] Departamento de Economía de la Empresa, Universidad Politécnica de Cartagena, España (joseangel.zabala@upct.es, cristina.marin@upct.es, erasmo.lopez@upct.es, md.miguel@upct.es, francisco.alcon@upct.es)

[2] Departamento de Economía Aplicada, Universidad de Murcia, España (joseantonio.albaladejo@um.es, jmpaz@um.es)

Paper prepared for presentation at the 172nd EAAE Seminar '*Agricultural policy for the environment or environmental policy for agriculture?*'

May 28-29, 2019.

Brussels.

A Valuation-Based Approach for Irrigated Agroecosystem Services

ABSTRACT

Agroecosystems main function is food, fiber and fodder provision. However, other ecosystem services (ES) are provided by these systems, such as the reduction of soil loss or the enjoyment of the landscape. Many of these ES do not take part in the market, but their valuation is important to develop a sustainable management of the system. Valuing ES requires a clear classification of ES and some efforts on the study and clarification of the ES classification has been carried out. Nevertheless, the assessment of non-market benefits requires defining and classifying ES according to the type of ecosystem studied and prioritizing the ES impact on social well-being. Thus, this work aims to develop an adaptation of the existing ES classification for irrigated agroecosystem ES valuation, and verify it through an agricultural stakeholders' consultation. Their contribution could permit to advance towards agricultural ES valuation. It would allow the implementation of management and policy actions which take into account the importance of agroecosystem ES provision and their impact on human well-being.

Key words: Agriculture, Choice experiment, Non-market valuation, Stakeholders, Sustainability.

1. INTRODUCTION

Agriculture produces more than food, fiber and fodder. Agricultural multifunctioality conceives agriculture also contributes to climate regulation and erosion control, provides biodiversity, and even generates an enjoyable landscape for leisure, recreation and environmental education (Huang et al., 2015). However, not all agricultural contributions to society are positive: groundwater pollution, rivalry for water resources or loss of wildlife habitat, are good examples of negative agricultural impacts (Zhang et al., 2007; Power, 2010). Therefore, agriculture is a multifunctional activity integrated within a socio-ecological system, specifically called agroecosystem.

ES, defined as the contributions of an ecosystem to human well-being (TEEB, 2010), provide then a framework to identify and analyze all the agricultural outputs. Thus, ES approach translates all agricultural contributions into well-being, reflecting that agriculture may impact on society beyond food supply. Most international accepted ES classifications (MEA, 2005; TEEB, 2010; Haines-Young and Potschin (CICES), 2012) agree on categorizing them according three main groups: provisioning, regulating and cultural services. The first one comprises all material agricultural contributions to social well-being obtained directly from agroecosystems, which mainly encompass food, fiber and fodder production as positive contribution, and rivalry for water resources in the case of negative contribution. Regulating services are those obtained from geo-chemical processes within the agroecosystem, contributing from temperature regulation to erosion control. Finally, cultural services comprise non-material benefits obtained from agroecosystems, such as aesthetic appreciation of agricultural landscape, or opportunities for recreation and tourism.

Despite its apparently simplicity, ES approach is complex to apply when it refers to agroecosystems (Jourdain and Vivithkeyoonvong, 2017). Agroecosystems produce a blend of positive and negative services, namely, agroecosystem services (AES) and agroecosystem dis-services (AEDS), respectively, which not necessarily move in the same direction, generating trade-offs in their provision (Zhang et al., 2007; Power, 2010). For instance, increasing food provision, which frequently requires more intensive agricultural practices, may be related to groundwater pollution or soil degradation (Zhang et al., 2007).

The management of agriculture has been traditionally based on economic decisions taken under the valuation of just a part of them: provisioning services, mainly due to their commodity characteristics. However, these services are only a part of the overall contribution of agriculture to society. Thus, the challenge here is to combine market and non-market valuation under a common framework which allows to translate the overall social contribution of agroecosystems into terms of social well-being. Effective and efficient management of agriculture requires merging both kind of valuation of AES and AEDS.

Since Costanza et al. (1997) made a first attempt to value ES provided by ecosystems worldwide, there is an increasing interest in improving the ES knowledge and valuation. MEA (2005), TEEB (2010) and CICES (2012) focused their research in classified ES in a general way, available for all kind of ecosystems. However, more efforts are needed in the case of agroecosystems, especially when the purpose is to value their AES and AEDS provision.

In this context, this work aims to propose a classification for AES and AEDS provided by irrigated agroecosystems and select the most relevant AES and AEDS for economic valuation through a stakeholder assessment. To reach this purpose, a literature review is firstly developed to know the state of the art of ES classification. Secondly, an ES and EDS classification focused on agroecosystem is proposed. And, finally, it is verified by means of an agricultural stakeholders' consultation in order to find relevant ES and EDS for agroecosystem valuation.

2. STATE OF THE ART

Costanza et al. (1997) represented the first attempt to measure the value of ES worldwide. Since then, big efforts have been made with the purpose of broadening the knowledge about ES concept, methods of quantifying and also valuating. Thus, a great diversity of ES approaches and classifications has been developed. MEA (2005), TEEB (2010) and CICES (2012) are the most internationally accepted classifications currently, showing more similarities than differences among them.

MEA (2005) defined ES as the benefits people obtain from ecosystems and established four main categories: provisioning services, which comprise the products obtained from ecosystems; regulating services, defined as benefits obtained from the regulation of internal processes within the ecosystems; cultural services, as non-material benefits obtained from ecosystems; and, finally, supporting services, which are the base for the production of the rest of ES. MEA (2005) was set up with the purpose of raising awareness with the contribution of ecosystems to society, and thus, advising decision makers the importance of ecosystems conservation and avoiding their deterioration.

Following Costanza et al. (1997) and MEA's (2005) recommendations, TEEB (2010) developed its own classification, understanding ES as direct and indirect contributions of ecosystems to human well-being. It also established four main categories of ES: provisioning, regulating, cultural and habitat services. TEEB's ES classification differentiates MEA's (2005) removing supporting services while including habitat services. The latter covers ecosystem's importance to provide habitat for migratory and stationary species, and thus, it is necessary linked to biodiversity. At this point, TEEB (2010) considered MEA's supporting services as included within regulating ES. Moreover, TEEB (2010) focuses its approach on economic valuation, taking the welfare economics viewpoint.

CICES (2012) defined ES similarly to TEEB (2010): contributions that ecosystems make to human well-being. At this sense, CICES (2012) classified ES within three sections: provisioning, regulating and maintenance, and cultural services. As we could notice, nor supporting neither habitat services are included within this classification, revealing that CICES's (2012) classification only considers final services. However, their approach differs from TEEB's (2010) in the sense that it is focused on ecosystem's national accounting.

Regarding the aim of proposing a valuation-based approach, TEEB (2010) represents the most adapted classification. Besides, TEEB (2010) is based on final services, avoiding double accounting bias (Fisher et al., 2009), which also enforces its selection as a proper classification for economic valuation. Table 1 summarizes the ES classification made by TEEB (2010), including main ES within each category and its associated economic value.

Table 1. TEEB's (2010) ES classification

ES definition	ES category	ES	Economic value
Direct and indirect contributions of ecosystems to human well-being	Provisioning	- Food - Water supply - Raw materials - Genetic resources - Medicinal resources - Ornamental resources	Direct use and option value
	Regulating	- Air quality regulation - Climate regulation - Moderation of extreme events - Regulation of water flows - Waste treatment and water purification - Erosion prevention - Maintenance of soil fertility - Pollination - Biological control	Indirect use and option value
	Cultural	- Aesthetic appreciation - Opportunities for recreation and tourism - Inspiration for culture, art and design - Spiritual experience - Information for cognitive development	Direct use, option and non-use value
	Habitat	- Maintenance of life cycles of migratory species - Maintenance of genetic diversity	Indirect use and non-use value

From the application of TEEB (2010) approach, some considerations should be made for irrigated agroecosystems to include that not all agroecosystem's contributions to human well-being are positive. Agroecosystem functionality also involves the provision of EDS, and thus, it should be included under the approach. For instance, bad agricultural practices might involve the increase of erosion rates, biodiversity loss or even groundwater pollution, which might negatively affect other related ecosystems. Therefore, the developing approach should provide a common framework to assess conjointly positive and negative impacts on individual well-being, i.e. AES and AEDS. Feed-back and trade-offs among AES and AEDS need to be altogether assessed. Moreover, regarding irrigated agriculture, rivalry for water resources between agricultural and non-agricultural activities should be considered, especially in arid and semi-arid areas with water scarcity problems, such as South-Mediterranean regions.

Not only provisioning and regulating, but also cultural services are slightly different in the case of agroecosystems. Employment provided by agriculture might be considered as a positive contribution to human well-being. In fact, although it is not considered as an ES itself, TEEB (2015) recognizes employment as a visible benefit derived from agroecosystems. Besides, traditional irrigated lands in Mediterranean regions have a specific cultural heritage related to water management and use: irrigation canals, water reservoirs, waterwheel…, which comprises elements rooted in the cultural identity of rural areas (Martínez-Paz et al., 2019).

3. METHODOLOGY

3.1. Case study

Case study is located in the Region of Murcia (South-East Spain), which is included within the Segura River Basin. This basin is characterized by a semi-arid climate with long periods of drought, which generates the increasing water demand for irrigation, the subsequent groundwater overexploitation and salinization, and the continuous biodiversity lost.

Segura River Basin's agroecosystems is based on a dual system, where irrigated agriculture, characterized by a high productivity and mainly based on citrus and horticultural crops (Alcon et al., 2017), takes place together with rainfed agriculture, with low profitability and almond orchards as the main crop. Specifically, irrigated agricultural lands cover around 52% of total agricultural area (CARM, 2016). Moreover, two different agroecosystems can be found within irrigated agroecosystems: one located in the Segura River valley and based on a traditional irrigation; and the other focused on modern irrigation, outside of the riverside and characterized by its high technological and intensification level.

3.2. Choice experiment method

Choice experiment (CE) is a stated preference method based on multi-attribute utility theory (Lancaster, 1966) and random utility theory (McFadden, 1974) whose aim is to explain individual discrete choices. Applying them to our work, the utility provided by an agroecosystem is the sum of utilities provided by each AES and AEDS supplied. Thus, in case they could, individuals would choose the agroecosystem which give them a higher utility level. CE approach has been widely applied to ES valuation for agricultural purposes (Rodríguez-Ortega et al., 2016; Novikova et al., 2017; Villanueva et al., 2017).

Agroecosystems comprise such socio-ecological complex relations that analysing AES and AEDS one-by-one forgets feedbacks and trade-offs among them (Power, 2010). Hence, CE is seen as a proper method to explore stakeholders' preferences, taking into account the overall complexity that ES assessment implies and allowing AES and AEDS analysis within a common framework.

3.2.1. Attributes and level selection

Attributes included within CE design are indicators associated to AES and AEDS identified in Section 2 for the particular case of agroecosystems, following TEEB (2010) approach. Thus, AES and AEDS were selected considering the case study characteristics: dual agriculture, aquifer salinization, soil degradation, water scarcity and social influence of agriculture. The final design comprised a set of 12 ES and EDS, categorized in: 2 provisioning, 4 regulating, 3 cultural and other 2 related to biodiversity. Attribute levels were chosen with the purpose of including the provision levels of AES and AEDS of the 3 main agroecosystems found in the case study: rainfed agroecosystem, traditional irrigated agroecosystem and modern irrigated agroecosystem. All of them were measured in physical units in order to improve the reliability of the CE. Table 2 summarizes attributes and levels.

Table 2. Attributes and levels

ES category	AES/AEDS (TEEB, 2010)	Attribute (Indicator)	Definition	Units	Levels
Provisioning	Food (AES)	Yield *(YIELD)*	Annual incomes perceived by farmers	€/ha/year	Low (500-3,000)* Moderated (10,000-20,000) > 20,000
	Water supply (AEDS)	Water supply for irrigation *(WATER)*	Changes in irrigation water consumption due to crop system	m^3/ha/year	0* 3,000-5,000 > 5,000
Regulating	Air quality regulation (AES)	Carbon balance *(CARBON)*	Net balance between CO_{2eq} emission and sequestration	tons of CO_{2eq}/ha/year	< 15* 15-30 > 30
	Climate regulation (AES)	Temperature regulation *(TEMPE)*	Temperature on the substrate surface	ºC	0* 1 ºC descent 2 ºC descent
	Erosion prevention (AEDS)	Erosion *(ERO)*	Loss of soil due to wind or precipitation	tons/ha/year	High* Low
	Waste treatment and water purification (AEDS)	Groundwater pollution *(POLL)*	Nitrates concentration in aquifers	mg NO_3/L	Low (0-50)* Moderated (50-200) High (> 200)
Cultural	Employment generation (AES)	Employment generation *(EMP)*	Labour related to agroecosystems maintenance	hours/ha/year	< 100* 100-500 > 500
	Spiritual experience (AES)	Cultural heritage *(CHERIT)*	Presence of cultural elements linked to water use	-	Absence (0)* Presence (1)
	Opportunities for recreation and tourism (AES)	Recreation and leisure *(RECRE)*	Chance of enjoying agroecosystems	-	Absence (0)* Presence (1)
	Aesthetic appreciation (AES)	Landscape *(LAND)*	Scenic landscape beauty	-	Dry land (0)* Traditional irrigated land (1) Intensive irrigated land
Biodiversity	Extreme events (AES)	Resilience *(RES)*	Ecosystem adaptability to environmental changes	-	High (0)* Low (1)
	Species (habitat service) (AES)	Bird species richness *(BIRD)*	Bird species diversity	% of natural species present in the agroecosystem	100 %* 80 % 60 %

*Rainfed agroecosystem (*SQ*)

Provisioning AES and AEDS were represented through the value of agricultural production (yield) and irrigated water use (water supply for irrigation) as indicators, respectively. Yield was selected as an attribute in order to represent food provision, homogenizing different crop production values. Water scarcity is the key that determines water management within Mediterranean agroecosystems. It has not only an impact on farming and policy making, but also on the entire society (Alcon et al., 2017; Perni and Martínez-Paz, 2017). Hence, water supply for irrigation increases the rivalry of different water uses, which necessarily might be translated into terms of social well-being.

Indicators associated to regulating AES and AEDS were carbon balance, temperature regulation, erosion and groundwater pollution. Carbon balance, defined as the net amount of greenhouse gases taken up by the agroecosystem, is considered a climate regulating AES affected by agricultural practices (Almagro et al., 2016). Irrigated agriculture can reduce local temperature (Mon et al., 2016), which is expected to have a positive impact on social well-being in arid and warm areas. Therefore, temperature regulation was included as an AES in the experimental design. Soil erosion represents one of the main processes which guides land degradation within Mediterranean agricultural landscapes affecting also to the provision of AES (van Leeuwen et al., 2019). Groundwater pollution is a growing phenomenon in Mediterranean countries, mainly caused by diffuse pollution from agriculture (Jiménez-Martínez et al., 2011).

Agroecosystems contribute to local employment, and thus increase social well-being (O'Campo et al., 2015). Agroecosystem capacity to generate employment was measured as the number of work hours needed to manage an agroecosystem. Additionally, agroecosystems provide other cultural ES, such as the existence of a cultural heritage related to the water management, the supply of an environment to enjoy leisure and recreation, and its contribution to generate a characteristic landscape highly influenced by irrigation.

Biodiversity is not considered an ES itself (TEEB, 2010) but it has an impact on the social well-being. Thus, biodiversity was measured by through two different indicators: resilience and bird species richness. Resilience was chosen as an attribute due to the importance of the agroecosystem to adapt to climate change scenarios, whilst bird species richness was employed owing to its deeply use in the literature (Varela et al., 2018) and its easiness to be understood by the society.

Attributes and levels were combined through an s-efficiency design using Ngene 1.0.2 software package (Rose et al., 2010). It was chosen as the most proper for this study due the reduced target population: agroecosystem stakeholder within the Region of Murcia. The final design comprises 18 choice sets grouped in 3 blocks, which were randomly assigned to the stakeholders. Hence, each stakeholder responded 6 choice sets consisted of 3 alternatives, which represented different agroecosystems for the case study: one rainfed agroecosystem, which was used as a status quo alternative (SQ), and two alternatives represented irrigated agroecosystems. This experimental design allows to explore stakeholder preferences for irrigated agroecosystem versus rainfed systems.

3.2.2. Data collection

Data were collected between July and September 2018 through face-to-face questionnaires and following a snowball sampling method (Biernacki and Waldorf, 1981). Agroecosystems' stakeholders of the Region of Murcia comprised the target population. Thus, the final sample was composed by 44 stakeholders, grouped in four categories:

- Users (11): Farmers and technicians who work on agroecosystems.

- Researchers (10): Agronomic engineers, scientists and economists who work on agroecosystems research.

- Public managers (13): Regional and national organisms related to water use and agricultural land management.

- Society (10): NGOs, labour unions, political parties and other social associations.

3.2.3. Econometric analysis

According to random utility theory (McFadden, 1974), the utility U_{ij} for an individual i provided by an alternative j can be decomposed as follows:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (1)$$

where V_{ij} represents deterministic elements of utility and ε_{ij} is a random error with an independent and identically distributed extreme value distribution (Train, 2009). If it is assumed a linear relation within the elements of V_{ij}, it can be written as:

$$V_{ij} = \sum \beta_k X_{ijk} \quad (2)$$

where X_{ijk} represents the k observable variables that determine utility, mainly, the attribute levels taken by the alternative j and the respondent characteristics, and β_k the marginal utility. A significance analysis is applied to the coefficients β_k in order to determine the relevance of ES to explain stakeholders' choices.

The most applied way to estimate individual utility function is the conditional logit (CL) model (Train, 2009). Nevertheless, CL model involves some restrictive assumptions, the most relevant being the independence of irrelevant alternatives (IIA), which assumes that the probability of choosing an alternative is not influenced by any other alternatives. IIA principle can be contrasted by Hausman test (Hausman and McFadden, 1984). If Hausman test's null hypothesis is not rejected, CL model is robust enough to estimate stakeholders' utility function.

4. RESULTS AND DISCUSSION

Stakeholders' preferences are analysed through a fixed-effects CL model (Table 3), whose specification has been selected as proper since Hausman test results (HT) validates the existence of IIA (HT = 4.24; $\chi^2_{0.05;11}$=19.675).

Results show a significant negative coefficient for rainfed agroecosystem (*SQ*) alternative, reflecting the disutility provided by rainfed agroecosystem in terms of AES and AEDS provided. The significance analysis of coefficients, that determines which ES and EDS really affect the stakeholders' utility function, shows that 6 out of 12 AES and AEDS are significant.

Relating to provisioning services, yield from agricultural activities (*YIELD*) (p-value < 0.15) and water supply for irrigation (*WATER*) (p-value < 0.05) are explaining stakeholder's choices in terms of AES and AEDS, respectively. The sign of the yield coefficient indicates that higher farm yield levels are preferred by stakeholders. Additionally, the negative sign of water supply for irrigation coefficient confirms a disutility of this attribute, representing an AEDS.

Regarding regulating ES and EDS, the coefficient of the attributes groundwater pollution (*POLL*) and temperature regulation (*TEMP*) are significant (p-value < 0.05). The negative sign of *POLL* coefficient reflects a high social concern about environmental impacts of agriculture in terms of pollution externalities. On the other hand, temperature regulation is an AES that can mitigate high temperatures in warm areas as its positive and relevant coefficient shows. However, erosion (*ERO*) and carbon balance (*CARBON*) are non-significant attributes, indicating the relative irrelevance of these services for stakeholder assessment.

Despite literature collects that many cultural ES impact on social well-being, only an AES, recreation and leisure (*RECREO*), shows a significant effect (p-value <0.05) on stakeholders' utility function within our case study. Although agricultural contribution to direct employment was expected to be significant due to the case study characteristic, attribute coefficient was not significant. Finally, agroecosystem biodiversity is significantly collected by bird species richness variable (p-value < 0.05).

Thus, 2 provisioning, 2 regulating, 1 cultural services, and 1 biodiversity indicator are the most remarked elements that should be included in agroecosystem valuation, due to their significant impact on social well-being according to stakeholder preferences. Moreover, rather than parameter values, another important analysis comes from the coefficient sign. It determines a positive or negative contribution to social well-being, which serves to verify the previously consideration of attributes as AES or AEDS. Coefficient signs for water supply for irrigation (*WATER*) and groundwater pollution *(POLL*) are negative. It corroborates their definition as AEDS, which necessary reflects the associated disutility to higher attribute levels. The rest of significant AES (*YIELD, TEMPE, RECRE, BIRD*) have a positive coefficient sign, showing that they are also considered as AES by the stakeholders.

Table 3. Estimated conditional logit (CL) model

	CL Model		
	Coef.	**Std. Err.**	**P-value**
SQ	-1.49	0.92	0.10
YIELD	2.45e-05	1.70e-05	0.14
WATER	-2.66e-04	1.33e-04	0.05
CARBON	0.02	0.01	0.17
TEMPE	0.34	0.14	0.02
ERO	-0.16	0.26	0.54
POLL	-0.01	0.00	0.00
EMP	1.85e-05	5.49e-04	0.97
CHERIT	0.05	0.25	0.85
RECRE	0.70	0.24	0.00
LAND	0.35	0.26	0.19
RES	0.03	0.28	0.90
BIRD	0.02	0.01	0.02
Number of stakeholders		44	
Log likelihood		-244.104	
LR chi^2		91.860	
Prob > chi^2		0.000	
Pseudo R^2		0.158	

5. CONCLUSIONS

The analysis of stakeholders' demand for AES and AEDS has been the base for establishing a conceptual framework for economic valuation of services provided by irrigated agroecosystems. Although it is mainly focused on TEEB (2010), this conceptual framework includes, at least, one AES or AEDS at every ES category developed by the main accepted classifications (MEA, 2005; TEEB, 2010; CICES, 2012), which strengthen the idea that agriculture is a multifunctional activity (Bernués *et al*., 2015; Ricart *et al*., 2019). According to provisioning services, food provision (AES) and water supply for irrigation (AEDS) have been considered relevant for economic valuation. In the case of regulating services, agriculture also provides both AES, such as temperature regulation, and AEDS, reflected by groundwater pollution. Besides, the value of agroecosystem for society is also provided by its contribution to cultural activities, leisure and recreation being the most relevant. Therefore, it is proven that agriculture produces more than only food and fibre to contribute to social well-being.

Some policy implications could be derived from results. Stakeholders reveal agricultural management should consider all agroecosystem contributions to human well-being, both positive and negative, and even the relations, feed-back and trade-offs, among them. It necessarily implies making decisions beyond only food provision, that is, beyond market valuation. Therefore, the management of agriculture should integrate market and non-market valuation under a common approach in order to develop agricultural policy measures with the greatest social support and design agri-environment schemes. Furthermore, results show that agricultural policy actions require focusing on maximizing AES while minimizing AEDS, that is, maximizing food provision, temperature reduction and biodiversity and promoting leisure and recreation within the agroecosystem, while minimizing water supply for irrigation and groundwater pollution. However, it is still necessary to go in depth the analysis of social demand of AES and AEDS which covers the entire society, and not only agroecosystem stakeholders.

REFERENCES

Alcon, F., García-Bastida, P. A., Soto-García, M., Martínez-Álvarez, V., Martín-Gorriz, B. and Baille, A. (2017). Explaining the performance of irrigation communities in a water scarce region. *Irrigation Science*, *35*, 193 - 203. https://doi.org/10.1007/s00271-016-0531-7

Almagro, M., de Vente, J., Boix-Fayos, C., García-Franco, N., Melgares de Aguilar, J., González, D., Solé-Benet, A. and Martínez-Mena, M. (2016). Sustainable land management practices as providers of several ecosystem services under rainfed Mediterranean agroecosystems. *Mitigation and adaptation strategies for global change*, *21*, 1029–1043. https://doi.org/10.1007/s11027-013-9535-2

Bernués, A., Rodríguez-Ortega, T., Alfnes, F., Clemetsen, M. and Eik, L. O. (2015). Quantifying the multifunctionality of fjord and mountain agriculture by means of sociocultural and economic valuation of ecosystem services. *Land Use Policy*, *48*, 170-178. https://doi.org/10.1016/j.landusepol.2015.05.022

Biernacki, P., and Waldorf, D. (1981). Snowball sampling: Problems and techniques of chain referral sampling. *Sociological methods and research*, *10*(2), 141-163.

CARM (2016). *Estadística Agraria Regional*. Comunidad Autónoma de la Región de Murcia (CARM): Consejería de Agua, Agricultura, Ganadería y Pesca. http://www.carm.es/web/pagina?IDCONTENIDO=80andIDTIPO=140andRASTRO=c$m59490 (Accessed 21 January 2019)

Costanza, R., d'Arge, R., de Groot, R., Farbek, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R., Paruelo, J., Raskin, R., Suttonkk, P. and van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature, 387*, 253–260.

Fisher, B., Turner, R. K., and Morling, P. (2009). Defining and classifying ecosystem services for decision making. *Ecological economics*, *68*(3), 643-653.

Haines-Young, R. and Potschin, M. (2012). Common international classification of ecosystem services (CICES, Version 4.1). *European Environment Agency*, *33*.

Hausman, J. and McFadden, D. (1984). Specification tests for the multinomial logit model. *Econometrica*, *52*(5), 1219-1240.

Huang, J., Tichit, M., Poulot, M., Darly, S., Li, S., Petit, C. and Aubry, C. (2015). Comparative review of multifunctionality and ecosystem services in sustainable agriculture. *Journal of Environmental Management*, *149*, 138-147. https://doi.org/10.1016/j.jenvman.2014.10.020

Jiménez-Martínez, J., Aravena, R., and Candela, L. (2011). The role of leaky boreholes in the contamination of a regional confined aquifer. A case study: The Campo de Cartagena region, Spain. *Water, Air, and Soil Pollution*, *215*(1-4), 311-327.

Jourdain D. and Vivithkeyoonvong S. (2017). Valuation of ecosystem services provided by irrigated rice agriculture in Thailand: a choice experiment considering attribute nonattendance. *Agricultural Economics*, *48*(5), 1-13. https://doi.org/10.1111/agec.12364

Lancaster, K.J. (1966). A new approach to consumer theory. *Journal of Political Economy*, *74*(2), 132-157.

Martínez-Paz, J. M., Banos-González, I., Martínez-Fernández, J. and Esteve-Selma, M. A. (2019). Assessment of management measures for the conservation of traditional irrigated lands: The case of the Huerta of Murcia (Spain). *Land Use Policy*, *81*, 382-391. https://doi.org/10.1016/j.landusepol.2018.10.050

McFadden, D., 1974. Conditional logit analysis of qualitative choice behavior. In: Zarembka, P., (Ed.), *Frontiers in Econometrics* (pp. 105-142). New York, USA: Academic Press.

Millennium Ecosystem Assessment (MEA) (2005). *Ecosystems and Human Well-being: Synthesis*. Washington DC, USA: Island Press.

Mon, J., Bronson, K. F., Hunsaker, D. J., Thorp, K. R., White, J. W. and French, A. N. (2016). Interactive effects of nitrogen fertilization and irrigation on grainyield, canopy temperature, and nitrogen use efficiency in overhead sprinkler-irrigated durum wheat. *Field Crops Research*, *191*, 54-65. https://doi.org/10.1016/j.fcr.2016.02.011

Novikova, A., Rocchi, L. and Vitunskienė, V. (2017). Assessing the benefit of the agroecosystem services: Lithuanian preferences using a latent class approach. *Land Use Policy*, *68*, 277-286. https://doi.org/10.1016/j.landusepol.2017.07.051

O'Campo, P., Molnar, A., Ng, E. Renahy, E., Mitchell, C., Shankardass, K., John, A. S., Bambra, C. and Muntaner, C. (2015). Social welfare matters: A realist review of when, how, and why unemployment insurance impacts poverty and health. *Social Science and Medicine*, *132*, 88-94. https://doi.org/10.1016/j.socscimed.2015.03.025

Perni, A. and Martínez-Paz, J. M. (2017). Measuring conflicts in the management of anthropized ecosystem: Evidence from a choice experiment in a human-created Mediterranean wetland. *Journal of Environmental Management, 203*, 40-50. https://doi.org/10.1016/j.jenvman.2017.07.049

Power, A. G. (2010). Ecosystem services and agriculture: tradeoffs and synergies. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365* (1554), 2959-2971. https://doi.org/10.1098/rstb.2010.0143

Ricart, S., Kirk, N. and Ribas, A. (2019). Ecosystem services and multifunctional agriculture: Unravelling informal stakeholders' perceptions and water governance in three European irrigation systems. *Environmental Policy and Governance*, *29*(1), 23-34. https://doi.org/10.1002/eet.1831

Rodríguez-Ortega, T., Bernués, A. and Alfnes, F. (2016). Psychographic profile affects willingness to pay for ecosystem services provided by Mediterranean high nature value farmland. *Ecological Economics*, *128*, 232-245.

Rose, J. M., Collins, A. T., Bliemer, M. C. J. and Hensher, D. A. (2010). *Ngene. 1.0.2 ed. Statistical Software*. ChoiceMetrics Pty Ltd.

The Economics of Ecosystems and Biodiversity (TEEB) (2010). *Mainstreaming the Economics of Nature: A Synthesis of the Approach Conclusions and Recommendations of TEEB*. London, UK: Earthscan.

The Economics of Ecosystems and Biodiversity (TEEB) (2015). *TEEB for Agriculture and Food: an interim report*. Geneva, Switzerland: United Nations Environment Programme.

Train, K. E. (2009) *Discrete Choice Methods with Simulation*. Cambridge, UK: Cambridge University Press.

Villanueva, A. J., Rodríguez-Entrena, M. Arriaza, M. and Gómez-Limón, J. A. (2017) Heterogeneity of farmers' preferences towards agri-environmental schemes across different agricultural subsystems. *Journal of Environmental Planninng and Management*, *60*(4), 684-707. https://doi.org/10.1080/09640568.2016.1168289 van Leeuwen, C. C. E, Cammeraat, E. L. H., de Vente, J. and Boix-Fayos, C. (2019). The evolution of soil conservation policies targeting land abandonment and soil erosion in Spain: A review. *Land Use Policy*, *83*, 174-186. https://doi.org/10.1016/j.landusepol.2019.01.018

Varela, E., Verheyen, K., Valdés, A., Soliño, M., Jacobsen, J. B., De Smedt, P., Ehrmann, S., Gärtner, S., Górriz, E. and Decocq, G. (2018). Promoting biodiversity values of small forest patches in agricultural landscapes: Ecological drivers and social demand. *Science of The Total Environment*, *619-620*, 1319-1329. https://doi.org/10.1016/j.scitotenv.2017.11.190

Zhang, W., Ricketts, T. H., Kremen, C., Carney, K. and Swinton, S. M. (2007). Ecosystem services and dis-services to agriculture. *Ecological Economics*, *64*(2), 253-260. https://doi.org/10.1016/j.ecolecon.2007.02.024