Ecological Economics 108 (2014) 36–48

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Socio-cultural valuation of ecosystem services: uncovering the links between values, drivers of change, and human well-being

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ARTICLE INFO

Article history:
Received 9 May 2012
Received in revised form 22 September 2014
Accepted 23 September 2014
Available online xxxx

Keywords:
Critical ecosystem services
Semi-arid watershed
Social perceptions
Stakeholders
Tradeoffs
Value conflicts

ABSTRACT

Ecosystem services studies currently lack information regarding stakeholders' socio-cultural values. This information is highly relevant to human well-being, which is the motivation of ecosystem services assessments. We present results from an analysis of stakeholders' perceptions of ecosystem services, well-being and drivers of change in two semi-arid watersheds in south-eastern Spain. Based on the information compiled through a literature review, participant observation and semi-structured interviews, we designed a questionnaire and conducted 381 interviews. Our results show that semiarid watersheds deliver a large variety of ecosystem services; however, these services are perceived in different ways. We identified five stakeholder groups, including: locals dependent on provisioning ecosystem services, locals not directly dependent on provisioning ecosystem services, environmental and local development professionals and rural and nature tourists. Overall, provisioning services related to traditional practices were perceived as highly important and highly vulnerable by every stakeholder group. However, we found contrasting perceptions of some ecosystem services among stakeholders and of the relevant drivers of change and well-being. We suggest that socio-cultural valuation is a useful tool to prioritize ecosystem services but more attention should be directed to emerging trade-offs. Linking values to other stakeholder perceptions might be a useful way to move forward in ecosystem services valuation.

1. Introduction

The ecosystem services (ES) concept was conceived as a metaphor and later used as a heuristic analytical tool to make explicit the links between ecosystem conservation and human well-being (Norgaard, 2010). Here, we define ES as the direct and indirect contributions of ecosystems to human well-being (de Groot et al., 2010). ES assessments aim to inform environmental management and planning using multiple indicators (e.g., ecological, socio-cultural and economic) (MA, 2005; TEEB, 2010). Recent critiques, however refer to the lack of explicit inclusion of the stakeholders in ES studies (Menzel and Teng, 2010; Seppelt et al., 2011). As a result, socio-cultural values[1] (i.e., social needs, perceptions and preferences towards ES) are currently missing or poorly investigated in the assessments (Bryan et al., 2010; Chan et al., 2012). Neglecting what matters to people in ES assessments may hinder the social and political relevance of the concept and thus, its usefulness to facilitate social change (Anton et al., 2010; Menzel and Teng, 2010).

Socio-cultural values vary among stakeholders due to a complex set of factors. They are context-dependent and may also be related to different objectives, concerns and priorities for ecosystem management (Lamarque et al., 2011). Some of the factors that shape the stakeholders' perceptions of ES are related to the type of knowledge they hold (i.e., experiential or experimental), their place attachment (Lamarque et al., 2011; Lewan and Söderqvist, 2002) and the way in which they interact with their natural surroundings (Russell et al., 2013). For instance, Sodhi et al. (2010) found that local stakeholders with a longer time of residency near protected areas placed more value on the ES provided by their ecosystems. Therefore, there are two fundamental aspects to take into account when conducting ES assessments. First, the selection of stakeholders is particularly important as it is likely to influence their outcome (Seppelt et al., 2011) and second, greater understanding of the factors underlying ES values (human needs, well-being concerns, the effect of drivers of change etc.) is required.

Although well-being is at the core of ES definition, studies rarely explicitly include it as part of ES assessments. However, human well-being surveys can be used, for instance, to evaluate the importance of ES and how changes in ES may affect people's needs and willingness to

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[1] We understand socio-cultural values as a type of assigned value as defined by Lockwood (1999), which denotes those values that people attach to things (goods or services), in this case to ecosystem services, expressed in non-monetary terms. These values, according to Brown (1984) and Bryan et al. (2010) incorporate a person's perception of the ecosystem service under valuation, their held values and associated preferences and the context of valuation. In the current study we considered the values relating to ecosystem service importance for human well-being and the vulnerability of those services to being lost or degraded.

http://dx.doi.org/10.1016/j.ecolecon.2014.09.028
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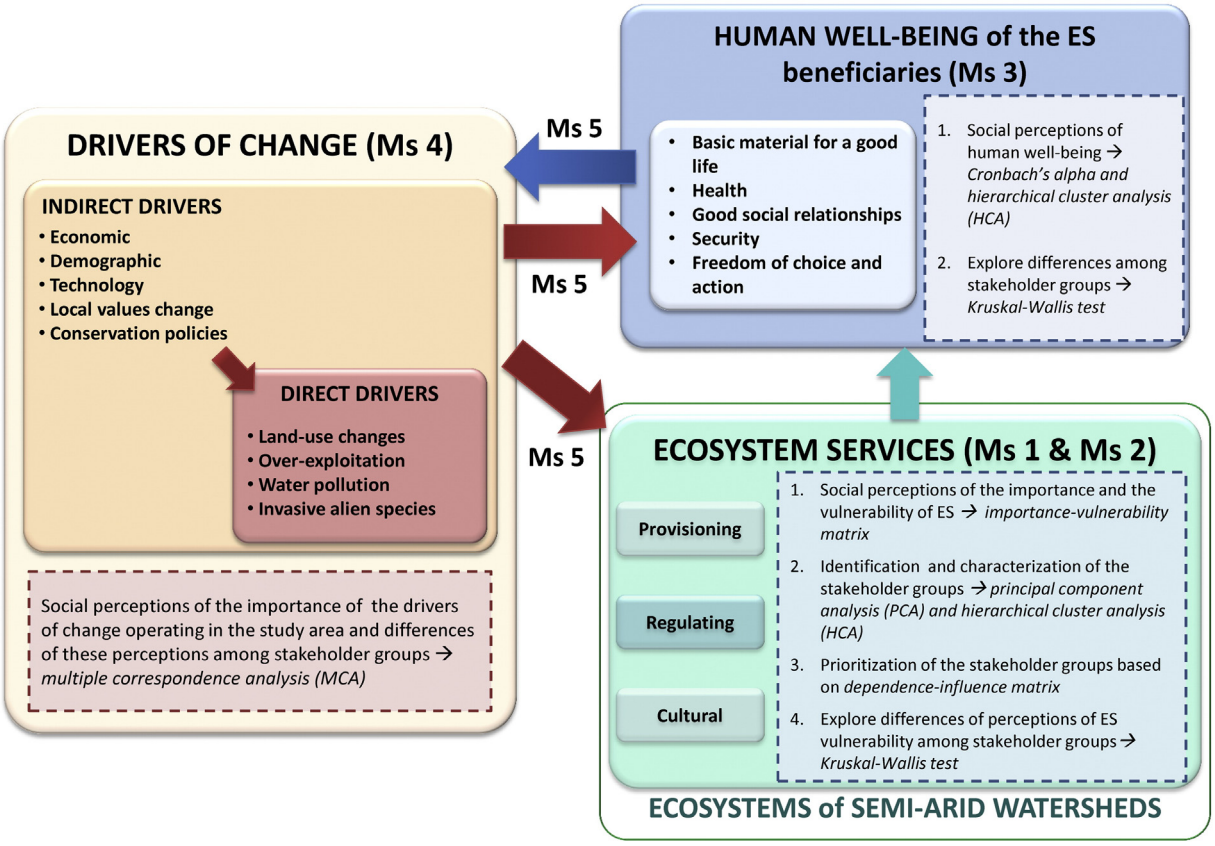

Fig. 1. Theoretical and methodological framework, modified from the MEA (2005) framework, representing the main relationships among ecosystem services, human well-being and drivers of change. Dashed lines refer to the methodological approach and the statistical techniques used for data analysis. Ms 1, Ms 2, Ms 3, Ms 4 and Ms 5 represent the specific methodological steps followed in the study.

maintain their quality of life (Smith et al., 2013). Furthermore, studies frequently overlook how changes in the delivery of ES affect the well-being of different stakeholder groups (Daw et al., 2011). This might be particularly relevant in the case of those stakeholders whose well-being is more directly dependent on ES (de Groot et al., 2006; Reed et al., 2009). Therefore, identifying the drivers of change[2] that shape ES delivery and its ultimate effect on the stakeholders' well-being emerges as an important issue (Chan et al., 2012; Smith et al., 2013; Summers et al., 2012).

In this study, we aim to empirically advance on the measurement of different socio-cultural values and how they relate to well-being and the effect of drivers of change. We do so using a conceptual framework modified from the Millennium Ecosystem Assessment (MA, 2005), which guides our objectives and the methodological steps we have followed (Fig. 1). We understand that the delivery of ES contributes to social well-being. Those stakeholders who participate in land-use decisions and planning can influence the effect of indirect and direct drivers of change. At the same time, drivers of change shape the stakeholders' well-being and ES flow (Fig. 1). Therefore, we take into consideration these three elements, i.e., ES, drivers of change and well-being assessing the stakeholders' perceptions. Using this conceptual and methodological framework, we aim to (1) identify the most important ES for well-being and the ES that are most vulnerable to loss or degradation, (2) analyze if and how perceptions of well-being and drivers of change relate to socio-cultural values and (3) provide useful insights for socio-cultural valuation of ES and for management. To do so we conducted the following specific methodological steps (Fig. 1): (1) performed a socio-cultural valuation of ES, (2) determined the main stakeholder groups that use and manage ES, (3) measured local stakeholders' views of well-being, (4) pinpointed the most important drivers of change and (5) identified the specific relationships among these perceptions.

We explored these objectives in two semi-arid watersheds in the southeast of Spain. Arid and semi-arid areas have been underrepresented in ES literature and considered marginal in ES assessments (O'Farrell et al., 2011; Reyers et al., 2009; Safriel et al., 2005). Furthermore, in these areas, there are often conflicting interests among multiple stakeholders about the use of vulnerable and scarce ES (Castro et al., 2011; García-Llorente et al., 2012b; Quintas-Soriano et al., 2014). Because of the nature of these vulnerable ecosystems, those stakeholders whose well-being is most dependent on an ecosystem's capacity to supply ES are also often vulnerable (Whitfield et al., 2011). Therefore, the need to conduct ES socio-cultural valuation emerges as a core issue in these areas.

2. Study Area

The semi-arid environments of Spain have recently been characterized as one of the most vulnerable ecosystems in terms of ES delivery (EME, 2011). We conducted the study in the Adra and Nacimiento watersheds, which are located in the provinces of Almeria and Granada in south-eastern Spain (Fig. 2). Both watersheds are in mountainous rural areas with a marked agrarian character. In the upper areas, a unique and multi-functional landscape has been designed to support subsistence farming on terraces as well as traditional irrigation systems such as acequias. Acequias have secured fresh water for humans and agriculture for centuries and have positively impacted other regulating services, such as hydrological regulation, water quality and local climate regulation (Pulido-Bosch and Ben Sbih, 1995).

[2] Here, drivers of change are defined as any natural or human-induced factor that directly or indirectly causes a change in an ecosystem (MEA, 2005; Nelson et al., 2006).

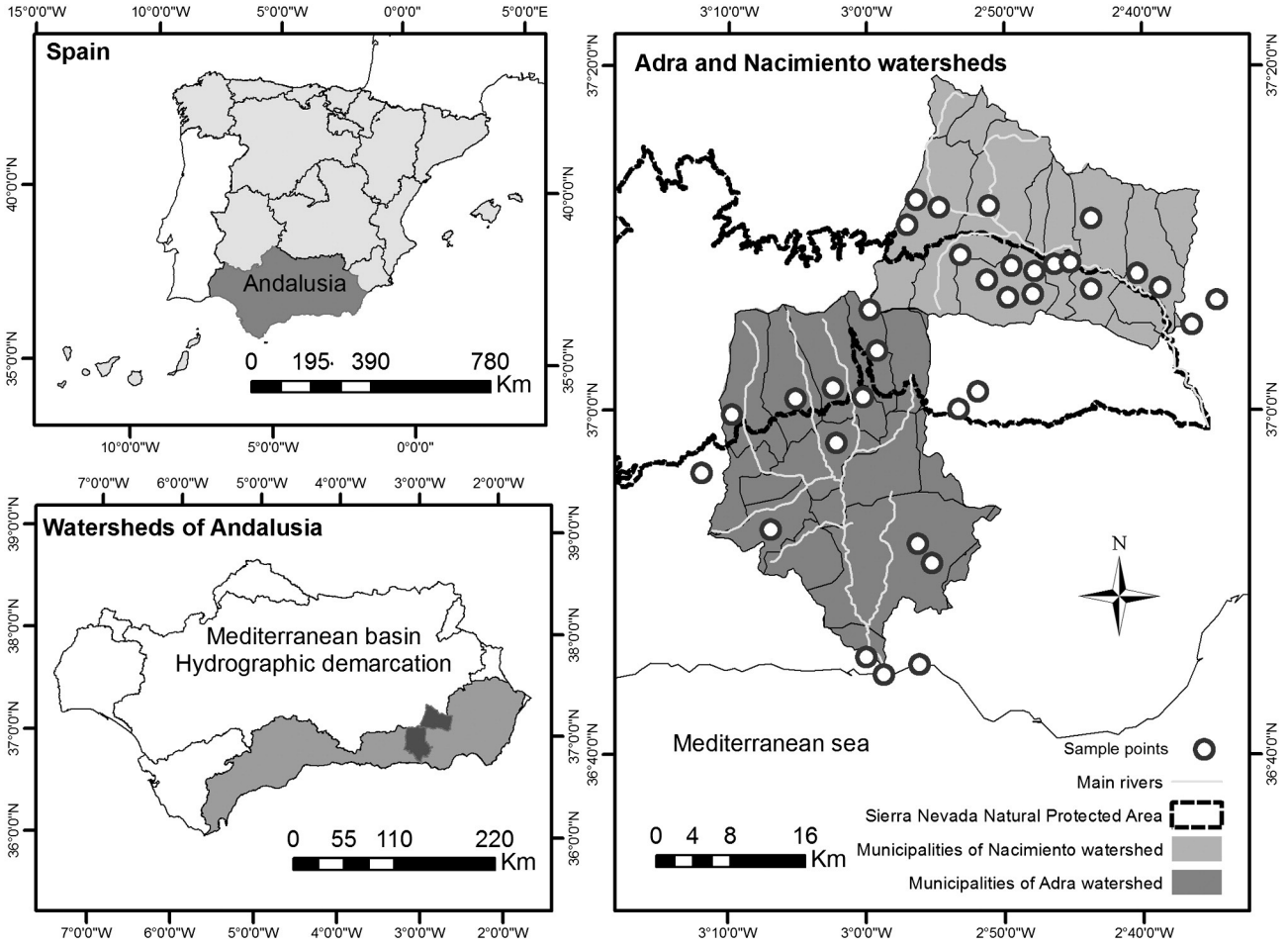

Fig. 2. Study area and face-to-face questionnaire sampling points.

Following a trend that started in the 1960s with the integration of local economies into global markets, subsistence farming has considerably diminished (Sánchez-Picón et al., 2011), triggering depopulation and landscape deterioration (Douglas et al., 1996). In contrast, lower areas, mainly in the Adra watershed, have developed competitive, intensive greenhouse horticulture since the 1980s, contributing to the phenomenon known as the "Almeria miracle" in which a "desert" turns into a main European horticulture producer (Aznar-Sánchez et al., 2011). This economic development has had varying socio-ecological consequences, including waste production, aquifer overharvesting, water pollution and social inequalities (García-Llorente et al., 2012b; Sánchez-Picón et al., 2011).

Appendix A shows the main features of both watersheds.

3. Methods

3.1. Study Design and Sampling Strategy

The fieldwork was conducted over a period of 15 months from November 2008 to February 2010. The research methods included a combination of qualitative and quantitative interview techniques adapted from different sub-global Ecosystem Millennium Assessments (e.g., Pereira et al., 2005; van Jaarsveld et al., 2005) and from previous research on ES assessments in Spain (García-Llorente et al., 2011a; Martín-López et al., 2011, 2012; Palomo et al., 2011). The techniques used entailed participant observation, semi-structured interviews and direct face-to-face surveys. The present study is part of a wider research project on ES in semi-arid areas in which biophysical, socio-cultural and economic methodologies have been applied (Castro et al., 2011; García-Llorente et al., 2011b, 2012a,b).

The fieldwork data sampling was conducted in three main stages. In the first stage, visits were performed to identify the study area and to organize meetings with local authorities and organizations to identify key informants in the area. In the second stage, during March and April 2009, we conducted 18 semi-structured interviews based on the following issues: (1) watershed management, (2) ES perception, (3) social and ecological conflicts, (4) human well-being and (5) future options based on the perceived drivers of change. We used the "snowball" sampling technique, asking key informants to identify other people with knowledge about the aforementioned issues. Information obtained in the first and second stages was used to design the questionnaire for the third stage, which was specifically related to the data obtained. In this sense, participant observation and semi-structured interviews were phases designed to build the content and structure of the questionnaire used. Then, in the third and final stage from May 2009 to February 2010, 381 face-to-face questionnaires were completed (200 in the Adra watershed and 181 in the Nacimiento watershed). This sample size was representative at a 95% level, yielding a sampling error of less than ±5%. The questionnaires included the following sections: (1) the respondents'[3] relationship with the study area; (2) the respondents' perception of important and vulnerable ESs in the area; (3) the

[3] We understand stakeholders as the individuals having a stake or interest in ecosystem services or those who are or may be affected by a public policy modified from Harrington et al. (2010). Here, we use the term respondents when we refer to people who answered the survey and to stakeholder groups to the groups of social actors that we obtained once we conducted the stakeholder analysis.

perception of well-being by the residents in the study area; (4) the drivers of change operating in the study area; (5) the respondents' environmental behavior and (6) socio-economic information. The questionnaire structure and content are presented in Appendix B.

The population sampled was randomly selected to cover a wide range of respondents' backgrounds, including local residents, workers (i.e., protected areas and local managers), researchers and tourists. The sample was restricted to people over 18 years of age. Random sampling was conducted using representative sampling points of regions, establishments and/or institutions (Fig. 2). In total, we covered 44 sampling points (places where questionnaires were administered) which included protected area offices, universities, urban zones, city halls, agrarian offices, recreational areas and agricultural fields. In all cases, the questionnaires were pre-tested.

To describe the methodology used for data analysis, we followed the structure established in the conceptual and methodological framework shown in Fig. 1.

3.2. Identification and Valuation of Important and Vulnerable ES

The first section of the questionnaire used in the survey (Appendix B) was designed to explore respondents' knowledge and familiarity with the study area and their existing knowledge about ES delivery. In the second section, each respondent selected the four ES most important for well-being and the four most vulnerable from a panel with examples and pictures of the potential ES provided by the area (including provisioning, regulating and cultural categories) (Appendix C). The list of ES was derived from the interviews, the use of bibliography and variants of classifications used in previous studies such as the Millennium Ecosystem Assessment (MA, 2005) and the Spanish National Ecosystem Assessment (EME, 2011). Appendix C shows the ES classification used in this study and how it fits into the proposed common international classification of ecosystem services (CICES; www.cices.eu) (Haines-Young and Potschin, 2013). The panels were chosen as a means to facilitate respondents' comprehension of ES. We avoided the use of technical terms to prevent educational and cultural biases.

Next, following Palomo et al. (2011), we classified ES into four types using an importance-vulnerability matrix: *critical* (perceived as both important for well-being and vulnerable), *important but not vulnerable*, *vulnerable but not important* and *less relevant* (neither are perceived as important for well-being nor as vulnerable). The aim of the importance–vulnerability matrix was to prioritize ES in the study area according to how they are perceived by the stakeholders that use or manage them. We calculated the median number of respondents, expressed in percentages, who perceived the ES' importance and vulnerability; we then used those figures as cut values to decide which ES were highly perceived as important or vulnerable.

3.3. Stakeholder Analysis: Identification, Characterization and Prioritization of Stakeholder Groups

We conducted a stakeholder analysis (Reed et al., 2009) organized in three main steps: identification, characterization and prioritization of the main stakeholder groups that are relevant to the ES management in the study area. From the different techniques to identify and characterize stakeholders (Reed et al., 2009), we employed quantitative techniques, specifically we performed a hierarchical cluster analysis (HCA) to identify the main stakeholder groups who used and managed ES in both watersheds. Previously, we applied a principal component analysis (PCA) to guarantee a standard measurement system and the absence of correlations between the factor scores (see García-Llorente et al., 2011a; Higuera et al., 2013 and Appendix D for more details on this methodology).

The variables used were related to the respondents' (1) relationship with the study area, (2) perceptions of ES importance and vulnerability, (3) socio-demographic characteristics and (4) environmental behavior (see variables in detail in Table D.1, Appendix D). The respondents' environmental behavior was elicited through a series of questions regarding their visits to protected areas, reading of environmental publications, purchasing of organic or fair-trade products and recycling, based on Birol et al. (2006) and García-Llorente et al. (2012a). These responses were measured using a Likert scale ranging from 1 (never) to 4 (always). The respondents were also asked whether they were members of an environmental group. An environmentally active behavior indicator, ranging from 1 to 4, was calculated using the Likert scores. We acknowledge that grouping questions regarding environmental behavior in an indicator might have downsides because those questions could be measuring different things. However, our interest was in having an overall measure that could be useful to describe each stakeholder group together with the rest of the variables in Table D.1, Appendix D.

We then developed a matrix of dependence-influence based on previous works on stakeholders' prioritization (de Groot et al., 2006; Reed et al., 2009). The most important objective associated with the prioritization of stakeholder groups was to determine which social actors were affected by changes to ES delivery and how influential they are on the ES decision-making processes (capacity to affect policies like watershed plans or sustainable development plans). The prioritization of stakeholder groups aims to focus on the most relevant stakeholders to the valuation process, making explicit power dynamics among them and allowing their targeting for later involvement (Reed et al., 2009). Therefore, the matrix aimed to identify and prioritize individuals and groups with different degrees of dependence on ES generated by the study area and with different degrees of influence over their management. Following this, we classified stakeholder groups in four types: with high degree of dependence on ES and high degree of influence in decision-making, high degree of dependence on ES but medium or low degree of influence in decision-making, low degree of dependence but high degree of influence and low degree of dependence and low degree of influence. Stakeholder groups were regarded as dependent based on the number of ES that respondents from a stakeholder group had recognized as important for their well-being. Therefore, when more than five ES were selected by more than 25% of the individuals in each stakeholder group, the stakeholder group was characterized as dependent. We assessed influence based on stakeholders' involvement in decision-making (i.e., if stakeholders were part of an administrative agency, municipality or other organization involved in decision-making).

Finally, we explored differences in the perceived vulnerability of the ES among the stakeholder groups by using the non-parametric Kruskal–Wallis test. Fig. 1 summarizes the statistical analysis used in this phase.

3.4. Local Perceptions of Well-Being

The third section of the questionnaire, targeting respondents living in the watersheds areas, explored the respondents' well-being through a set of 20 items related to the five components of human well-being identified in the Millennium Ecosystem Assessment (MA, 2005). These components include basic materials for a good life, health, good social relations, security, and freedom of choice and action[4] (Appendix B). These items were also measured on a Likert scale, ranging from "completely disagree (=1)" to "completely agree (=4)". Within this set of questions, an item relating to general life satisfaction was included because this question has been found to be particularly important when measuring well-being (Nef, 2012; Smith et al., 2013; Summers et al., 2012). Well-being was therefore measured at an individual level, i.e., we asked each

[4] Freedom of choice and action has been defined by the MEA (2005) as "the ability of individuals to control what happens to them and to be able to achieve what they value doing or being".

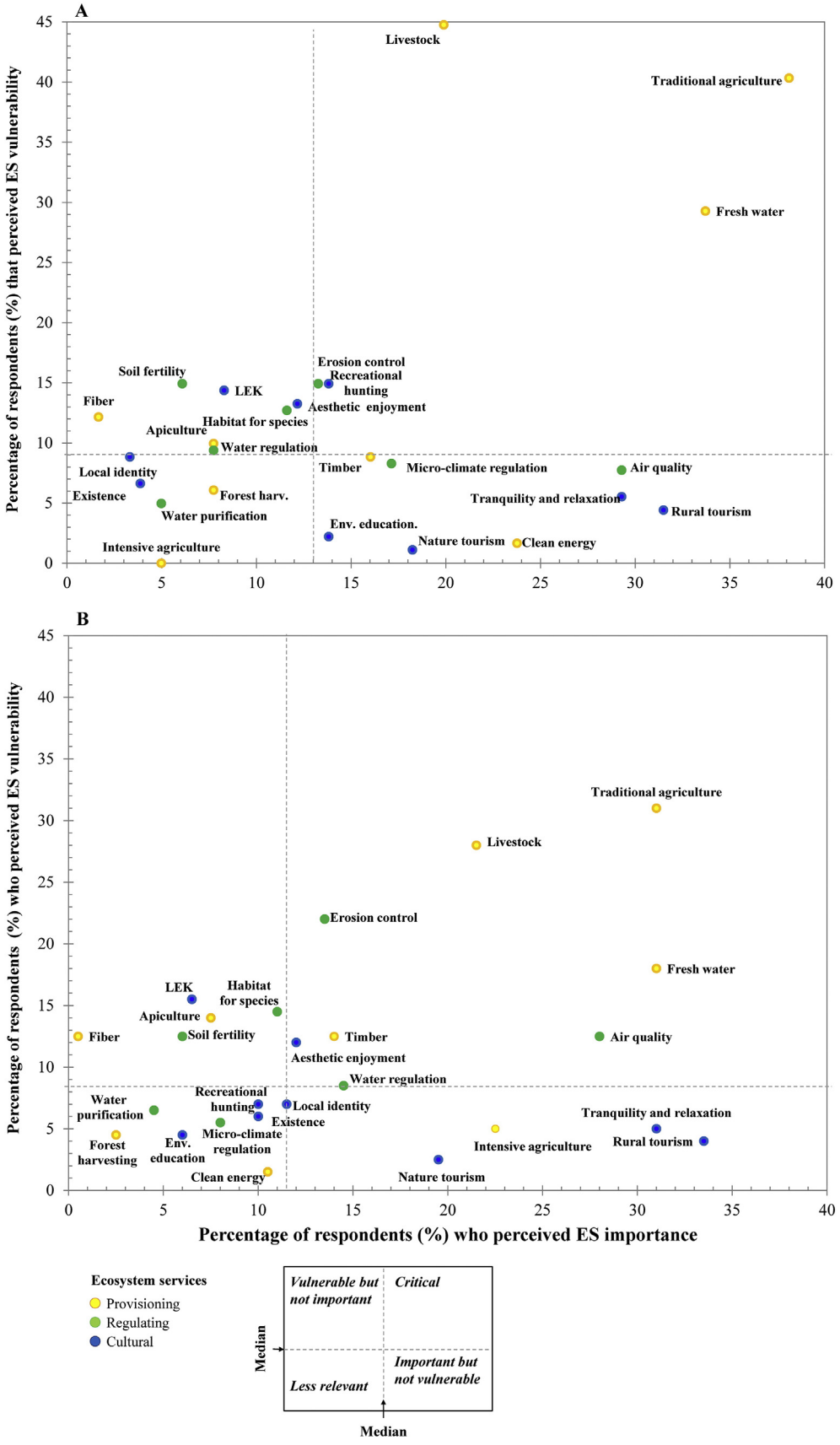

Fig. 3. Scatter-plots representing the perceived importance of ecosystem services for well-being (X-axes) and the perceived vulnerability (Y-axes) for the (A) Nacimiento and (B) Adra watersheds.

respondent to answer these questions, but since well-being is a multidimensional concept some items are related to higher levels than the individual, for example, the perceptions on the community performance.

To examine the responses regarding well-being, we first used Cronbach's alpha test (Cronbach, 1951) to analyze the internal consistency of the 20 well-being items. Second, we performed an HCA to explore how the different components of human well-being were perceived and identified, we then averaged the scores obtained for the different clusters, and lastly we used Kruskal–Wallis to compare the stakeholder groups' average well-being.

3.5. Identification of the Most Important Drivers of Change

The relationships among direct and indirect drivers of change were analyzed using a multiple correspondence analysis (MCA), which was based on 12 variables compiled through items representing drivers of change in the fourth section of the questionnaire (Appendix B). The drivers of change entailed both direct drivers, which directly influence ecosystem processes (i.e., land-use change, species extinction and species introduction, water flow contamination and overharvesting of water resources) and indirect drivers of change, which alter one or more direct drivers (e.g. demographic, economic, technological, political and cultural drivers) (sensu Nelson et al., 2006).

We investigated differences in the perception of drivers among stakeholder groups, using the stakeholder typology as a supplementary variable.

3.6. Links Between Drivers of Change, Vulnerability of ES and Their Effect on Human Well-Being

Lastly, we used a Pearson correlation analysis to test the relationships among the drivers of change, the vulnerability scores of ES and their effect on human well-being. We also used a PCA to reduce the list of vulnerable ES, drivers of change and dimensions of human well-being into components. These components show: (1) different bundles of ES (i.e., sets of services that appear together repeatedly sensu Raudsepp-Hearne et al., 2010), (2) the relationships with human well-being and (3) how they are affected by drivers of change. Bartlett's test of sphericity (Bartlett, 1954) was used to test whether correlations existed among the variables.

4. Results

4.1. Perceptions of ES Importance and Vulnerability

Overall, traditional agriculture, livestock, fresh water and erosion control were the *critical* ES (both perceived as important for well-being and vulnerable) in both watersheds. However, both watersheds presented differences in ES perceptions according to the different socio-economic characteristics and land-management strategies of the watersheds, which are described in more detail in Appendix A (Fig. 3). In the Nacimiento watershed, recreational hunting was also found to be *critical* (Fig. 3A) and in the Adra watershed (Fig. 3B) four other ES were also included in this category: aesthetic values, timber, water regulation and air quality.

The *important but not vulnerable* category was characterized mainly by cultural ES in both watersheds including rural tourism, tranquility and relaxation, and nature tourism. However, intensive agriculture was regarded as *important but not vulnerable* in the Adra watershed whereas it was perceived as *not relevant* in the Nacimiento watershed. This reflects the magnitude of this activity in the economic income of the Adra watershed whereas in the Nacimiento watershed it is present but not one of the main sources of income. The opposite applies to clean energy (i.e., wind and solar energy), which is regarded as *important but not vulnerable* in the Nacimiento watershed but as *not relevant* in the Adra watershed.

The category of *vulnerable but not important* ES included local ecological knowledge (LEK),[5] habitat for species, apiculture, soil fertility and fiber harvesting. Lastly, in the category of *less relevant* services, we found some regulating (e.g., water purification), some provisioning (e.g., forest harvesting) and some cultural services (e.g., existence value of biodiversity).

4.2. Stakeholder Analysis and Differences in Perceived Vulnerability Among Stakeholder Groups

We used a PCA and a HCA to identify the main stakeholder groups who used and managed ES in both watersheds. More details of this procedure can be found in Appendix D. The HCA identified five groups of stakeholders with a dissimilarity coefficient of 71.2%. These comprised two groups of local stakeholders, one group of environmental and local development professionals and two groups of tourists (Fig. 4). Table 1 summarizes the main stakeholder groups' characteristics and Table 2 shows the results of the Kruskal–Wallis tests where the perceptions of vulnerable ES by each stakeholder group were compared. The local stakeholder groups comprised *locals dependent on provisioning ES* and *locals not directly dependent on ES*. Both groups consisted of people who resided in the study area and whose level of education, income and environmental behavior was low; however, their level of knowledge and familiarity with the study area was high. *Locals dependent on provisioning ES* were those local stakeholders whose jobs were related to provisioning services, mainly agriculture, livestock and forestry. By contrast, *locals not directly dependent on provisioning ES* were local residents whose work depended on other activities not strongly related to farming or forestry. Both groups of locals perceived provisioning services and some cultural services such as recreational hunting as highly vulnerable, even though *locals dependent on provisioning ES* perceived fresh water as more vulnerable (Table 2).

The *environmental and local development professionals* group was comprised of people who lived in and near the watersheds and whose level of formal education, knowledge and familiarity with the study area was high. These people worked at local administrations, protected areas, local development organizations and research centers. This group showed the highest environmental behavior and was the one that most recognized the importance of the watersheds studied as providers of ES (Table 1). This group identified greater numbers of vulnerable ES (Table 1) and perceived as particularly vulnerable fresh water, LEK and erosion control as well as traditional agriculture and livestock, which were the ESs perceived as vulnerable by all stakeholder groups (Table 2).

The tourist groups were comprised of *rural tourists* who lived in the cities of Almeria and Granada and their surroundings and *nature tourists* who traveled greater distances to visit the study area and who mainly came from Andalusia and other Spanish provinces. Whereas the main motivations of the *rural tourists* were local traditions, gastronomy and relaxation, the *nature tourists* were motivated by nature, the quality of the environment and outdoor activities. *Nature tourists* visited a higher number of protected areas and showed higher environmental behavior. Both types of tourists provided higher percentages of perceived vulnerability of regulating services, especially for air quality, erosion control, soil fertility and habitat for species (Table 2). However, they perceived some provisioning services as less vulnerable (e.g., fresh water and also livestock in the case of *nature tourists*).

Lastly, Fig. 5 shows stakeholders' prioritization according to their appraisals of the importance of ES and the influence they have on their management. We identified *environmental and local development*

[5] An anonymous referee raised some concerns about the suitability of LEK as an ES, however we decided to include it in the classification used in this study as it fits different classifications that have considered it a cultural service such as MA ("knowledge systems"), TEEB ("information for cognitive development") and CICES ("educational or cultural").

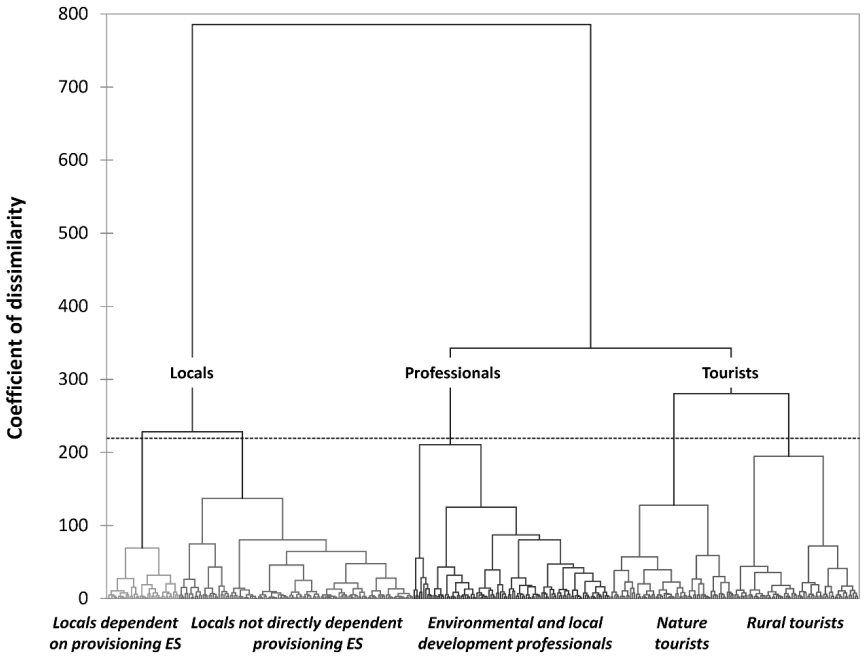

Fig. 4. Identification of stakeholders in the Adra–Nacimiento watersheds through hierarchical cluster analysis (HCA). The Euclidean distance and Ward's method were used as agglomerative techniques.

professionals as with high dependence on ES and high influence in decision-making. This stakeholder group included respondents who belonged to regional public administrations (i.e., the Sierra Nevada protected area, water, environmental and agricultural agencies), local administrations (i.e., local development agencies, social innovation agencies and local councils) and local agrotourism companies. We identified *locals dependent on provisioning ES* and *locals not directly dependent on provisioning ES* as stakeholder groups with high dependence on ES but limited influence in decision-making. These stakeholders often have limited influence in decision-making because they are not involved in groups or agencies in charge of ES management and neither are they part of larger groups that could influence decisions such as cooperatives or unions, which are almost non-existent in these areas. Lastly, we identified rural and nature tourists as with low dependence on ES and low influence in decision-making, because they do not rely heavily on the ES provided by both watersheds. These two groups identified a lesser number of ES important for their well-being and they did not have a high influence in decision-making relative to ES management.

4.3. Perceptions of Well-Being

The reliability for the human well-being items, as determined by Cronbach's alpha, was 0.69. This result suggests that the different dimensions of human well-being are highly inter-correlated. The HCA shows how different components of well-being relate to each other (Fig. 6). The following three main groups of dimensions of human well-being were identified: one cluster grouping answers regarding four of the five components of human well-being (i.e., basic materials for a good life, health, good social relations and security) and two clusters regarding individual and community freedom of choice and action, the fifth component of human well-being. Individual freedom of choice was expressed in terms of the respondents' individual participation in

Table 1
Characterization of the main stakeholder groups obtained through multivariate analysis (principal component analysis and hierarchical cluster analysis). (ES = ecosystem services; ENGOs = environmental non-governmental organizations; PAs = protected areas). *Variables ranging from never (1) to always (4).

Stakeholders (%)	N ES perceived	Environmental behavior					Socio-demographic variables				
		Membership of ENGOs (%)	PAs visited (last year)	Reading of environmental publications*	Purchase of organic products or fair-trade*	Recycling*	Place of residence	Level of formal education	Age (years)	Income (€/year)	Gender (%)
Locals dependent on provisioning ES (9.6%)	3	0%	Less than 1	1.3	2.4	3.1	In watersheds	Primary	51.7	950	Male: 65% Female: 35%
Locals not directly dependent on provisioning ES (31.2%)	2	2%	Less than 1	1.8	2.3	2.6	In watersheds	Secondary	43.1	1188	Male: 83% Female: 17%
Environmental and local development professionals (26.2%)	4	32%	More than 2	2.3	2.3	3.3	In watersheds and watersheds' surroundings	University	41.4	1589	Male: 62% Female: 38%
Rural tourists (16.5%)	2	0%	Less than 1	1.6	1.9	2.6	Almeria and Granada	Secondary	39.9	1461	Male: 47% Female: 52%
Nature tourists (16.5%)	3	32%	More than 3	2.0	2.4	3.1	Andalusia, Spain	University	36.1	1637	Male: 63% Female: 37%

Table 2
Vulnerable ES considered by stakeholders, in percentage (%) and differences of perceived vulnerability among stakeholders as calculated by the Kruskal–Wallis test. (LEK = local ecological knowledge) (*** and ** indicate statistical significance at the 0.01 and 0.05 levels, respectively).

Ecosystem services	Stakeholders					
	Locals not directly dependent on provisioning ES	Locals dependent on provisioning ES	Environmental and local development professionals	Rural tourists	Nature tourists	Kruskal–Wallis test
Provisioning						
Traditional agriculture	38.66	44.44	38.00	26.98	28.57	$\chi^2 = 4.59$
Intensive agriculture	3.36	5.56	3.00	0.00	1.59	$\chi^2 = 5.34$
Livestock	43.70	47.22	38.00	31.75	15.87	$\chi^2 = 13.64^{***}$
Forest harvesting	6.72	2.78	6.00	4.76	3.17	$\chi^2 = 1.09$
Apiculture	14.29	13.89	13.00	9.52	7.94	$\chi^2 = 4.37$
Fresh water	27.73	41.67	22.00	15.87	14.29	$\chi^2 = 12.45^{**}$
Fiber harvesting	12.61	25.00	13.00	7.94	7.94	$\chi^2 = 9.05^{**}$
Timber	15.13	13.89	6.00	7.94	11.11	$\chi^2 = 4.72$
Clean energy	2.52	2.78	1.00	0.00	1.59	$\chi^2 = 4.15$
Regulating						
Air quality	9.24	5.56	7.00	14.29	15.87	$\chi^2 = 5.81$
Micro-climate regulation	6.72	5.56	8.00	4.76	7.94	$\chi^2 = 0.68$
Water purification	4.20	2.78	6.00	4.76	11.11	$\chi^2 = 4.26$
Soil fertility	11.76	13.89	16.00	14.29	12.70	$\chi^2 = 1.62$
Habitat for species	6.72	11.11	14.00	15.87	25.40	$\chi^2 = 14.12^{***}$
Water regulation	5.04	5.56	13.00	7.94	12.70	$\chi^2 = 5.42$
Erosion control	14.29	5.56	25.00	25.40	17.46	$\chi^2 = 10.97^{**}$
Cultural						
Existence	5.88	5.56	7.00	6.35	6.35	$\chi^2 = 0.411$
Tranquility and relaxation	2.52	2.78	7.00	4.76	9.52	$\chi^2 = 7.22$
LEK	10.08	8.33	28.00	11.11	11.11	$\chi^2 = 19.51^{***}$
Environmental education	2.52	2.78	4.00	6.35	1.59	$\chi^2 = 1.20$
Aesthetic enjoyment	7.56	13.89	19.00	14.29	9.52	$\chi^2 = 4.63$
Local identity	5.04	2.78	12.00	7.94	9.52	$\chi^2 = 7.58$
Recreational hunting	19.33	11.11	10.00	6.35	0.00	$\chi^2 = 17.44^{***}$
Nature tourism	2.52	0.00	2.00	3.17	0.00	$\chi^2 = 2.77$
Rural tourism	3.36	2.78	7.00	4.76	1.59	$\chi^2 = 2.34$

community issues such as volunteering, meeting attendance and contributions to charity practices. Community freedom of choice was expressed in terms of having the opportunity to participate freely in community management, having leaders who advocate for the entire community and community entrepreneurship (Appendix E). The general cluster, entailing basic materials, health, good social relations and security, had a better overall rating than those regarding freedom of choice and action. In fact, freedom of choice and action items presented the highest figures of standard deviation (Appendix E), meaning that perceptions among stakeholder groups differed significantly in the

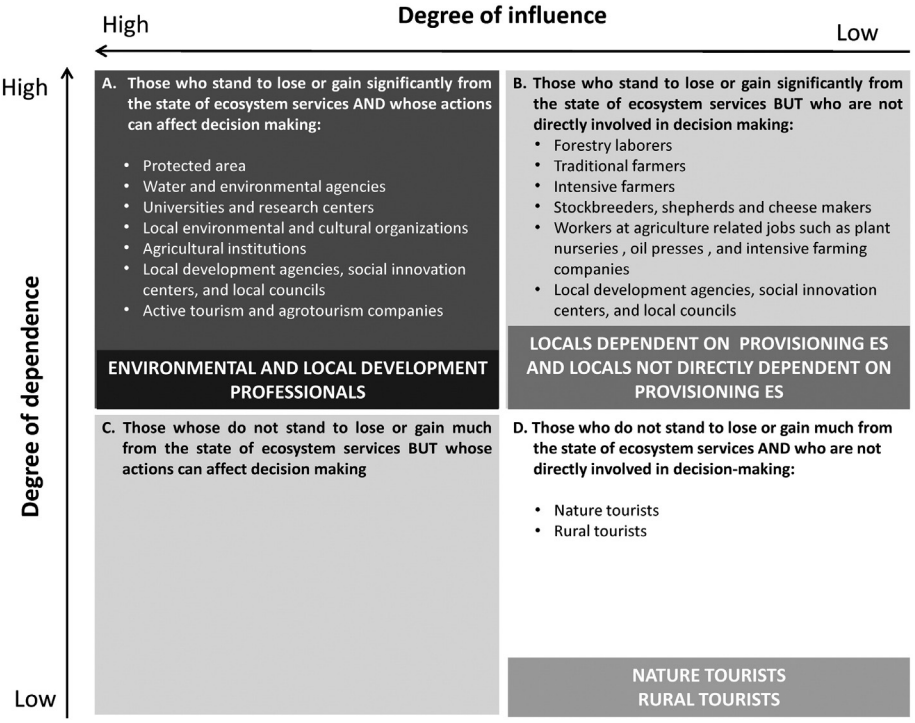

Fig. 5. Dependence-influence matrix showing in detail the different typologies of stakeholders.

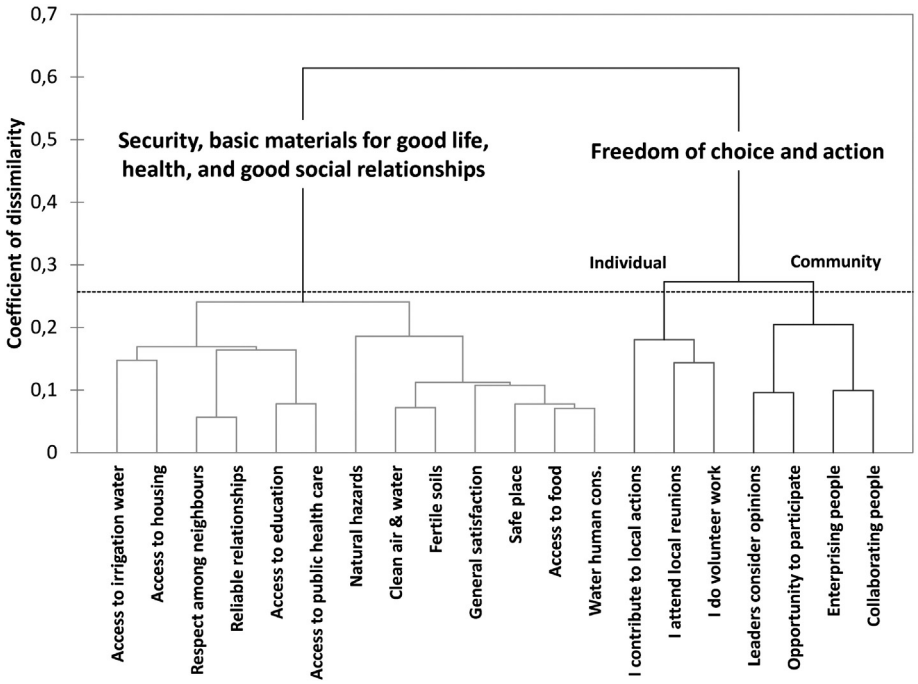

Fig. 6. Hierarchical cluster analysis (HCA) performed with questions regarding the five different components of well-being at the local level among the three types of stakeholders: *environmental and rural development professionals*, *locals dependent on provisioning ES* and *locals not directly dependent on provisioning ES*. The Bray and Curtis distance and Ward's method were used as agglomerative techniques.

issues related to freedom of choice. This was later confirmed by non-parametric analyses where the well-being cluster that contained items of perceptions of security, basic materials for a good life, good social relations (Kruskal–Wallis, $\chi^2 = 1.18$, d.f. = 2, p-value = 0.55) and community freedom of choice and action (Kruskal–Wallis, $\chi^2 = 0.87$, d.f. = 2, p-value = 0.65) did not show differences among stakeholder groups (i.e., the *environmental and local development professionals*, *locals dependent on provisioning ES and locals not directly dependent on provisioning ES*). There were, however, significant differences for individual freedom of choice and action (Kruskal–Wallis, $\chi^2 = 10.40$, d.f. = 2, p-value < 0.01), with the *environmental and local development professionals* showing a higher

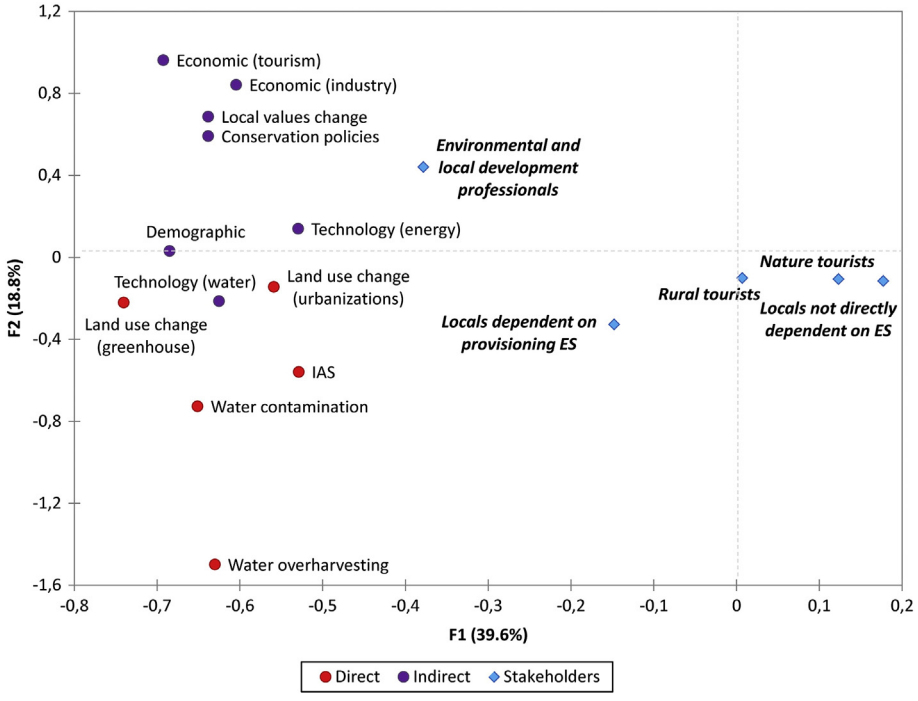

Fig. 7. Multiple correspondence analysis (MCA) of the drivers of change (direct and indirect) and stakeholder typology. Axes 1 and 2 account for 39.6% and 18.8% of the inertia, respectively. The relative closeness of the variable positions (mainly the drivers of change) along axis 1 reflects their tendency to be associated.

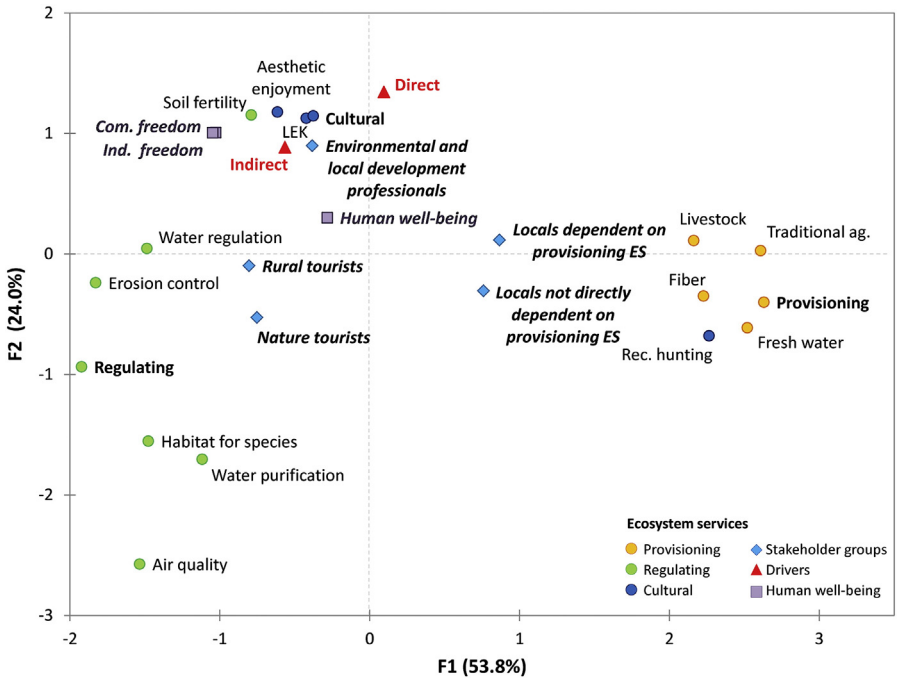

Fig. 8. Principal component analysis (PCA) plot of stakeholders, vulnerable ecosystem services, drivers of change and human well-being dimensions. The two axes of the PCA plot represent 78% of the data variability; the first axis contributes 54% and the second contributes 24%.

score, indicating that they participate more in local life than the other local stakeholders.

4.4. Identification of the Most Important Drivers of Change

The first three factorial axes of the MCA accumulated 63.7% of the total inertia (Fig. 7). The first axis (39.6%) revealed that the stakeholders who most strongly perceived the influence of the drivers of change were the *environmental and local development professionals* and *locals dependent on provisioning ES*. Axis 2 (18.8%) distinguished the perceptions of the indirect and direct drivers of change. The MCA revealed that the two groups of drivers of change can be differentiated (Fig. 7): (1) the effect of economic development, conservation policy implementation and changes in local values (i.e. indirect drivers of change), which were perceived by the *environmental and local development professionals* as shown in the positive loadings and (2) the effect of the technological development that is associated with water exploitation on land-use changes, water contamination and water overharvesting (i.e., direct drivers of change), which were mainly perceived by the *locals dependent on provisioning ES* as shown in the negative loadings.

4.5. Relationships Between Perceptions of Vulnerable ES, Drivers of Change and Human Well-Being

The results of Bartlett's test of sphericity were significant ($p < 0.001$), indicating that the perceptions of the vulnerable ES, drivers of change, dimensions of well-being and the different stakeholder groups were related. The first PCA axis (53.8% of the total variance) represented in the positive loadings the perceptions of vulnerable provisioning services associated with *locals dependent on provisioning ES* and *locals not directly dependent on provisioning ES*, and in the negative loadings the perceptions of vulnerable regulating services (Fig. 8). The second PCA axis (24.0% of the total variance) represented in the positive loadings, *environmental and local development professionals* associated with perceptions of cultural ES — particularly aesthetic values and LEK — and soil fertility as vulnerable ES, direct and indirect drivers of change, high perceptions of individual and community freedom of choice and action. In the negative loadings the perceptions of regulating services as vulnerable ES were associated with *nature tourists* (Fig. 8). This was also confirmed by the results of the Pearson correlation analysis (Table 3) where the perceptions of ES, drivers of change and well-being were highly correlated. Specifically, we found that individuals

Table 3
Correlation among the perceived vulnerable ES, drivers of change and human well-being dimensions. The values shown in the table are the Pearson correlation coefficients (R). (LEK = local ecological knowledge). (***, **, and * indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively).

	Perceived vulnerable ESs			Drivers of change		Human well-being	
	Soil fertility	Aesthetic enjoyment	LEK	Direct	Indirect	Community freedom	Individual freedom
Soil fertility	–						
Aesthetic enjoyment	0.996***	–					
LEK	0.767	0.738	–				
Direct	0.933**	0.949**	0.771	–			
Indirect	0.665	0.623	0.978***	0.629	–		
Community freedom	0.912**	0.878**	0.873*	0.843*	0.804*	–	
Individual freedom	0.900**	0.864*	0.893**	0.828*	0.835*	0.998***	–

who had higher perceptions of individual and community freedom of choice and action also perceived the effect of direct drivers on certain ES (namely soil fertility and aesthetic values), and the effect of indirect drivers of change on LEK.

5. Discussion

5.1. Socio-Cultural Valuation of ES: Critical, Important, Vulnerable and Less Relevant Services

Following our first objective we classified ES depending on the degree of perceived importance and vulnerability in four types: *critical*, *important but not vulnerable*, *vulnerable but not important* and *less relevant*. Overall, we found that *critical* ES in both watersheds were highly related to the agrarian and semi-arid characteristics of the study area, i.e., provisioning services related to traditional activities (traditional farming and livestock), fresh water and erosion control. A plausible explanation of this result is that people tend to identify ES that can be perceived by the senses (Lewan and Söderqvist, 2002) or those that are more directly linked to the human-made components of landscapes (e.g., agriculture and other extractive activities) (Lamarque et al., 2011). However, opposing the arguments that people tend to identify tangible ES, recent studies show that, regulating and cultural ES (associated with less tangible components of landscapes) are also highly identified by stakeholders in rural systems, as is the case here for erosion control (Hauck et al., 2013; Martín-López et al., 2012, 2014). Also, the decline of traditional food systems in Europe is an issue that transcends the local scale to the national and international scales (Bernaldez, 1991; MacDonald et al., 2000) and might make every stakeholder group aware of their vulnerability. Finally, another explanation that could clarify why provisioning ES are highly identified as *critical* in the study area relates to the contribution of these traditional activities not only to food but to the delivery of other ES, such as landscape aesthetics or local identity, and to its direct contributions to well-being. This is also consistent with previous social research in the study area (García-Llorente et al., 2012b), and other rural areas suffering from depopulation (Pereira et al., 2005) where traditional agriculture was highly related to the maintenance of local identity and to the contribution of social capital and enhancement of well-being.

The ES in each category (i.e., *critical*, *important but not vulnerable*, *vulnerable but not important* and *less relevant*) also varied between the Adra and Nacimiento watersheds according to the different land-management of each study area. More services were considered *critical* in the Adra watershed than in the Nacimiento. The Adra watershed has been subject to higher land intensification during the last three decades, promoting a deterioration in the ES flow (Garzón-Casado et al., 2013; Sánchez-Picón et al., 2011).

5.2. Acknowledging the Diversity of Stakeholders' Values and Perceptions as a Tool to Uncover ES Trade-Offs

Following our second objective, we disaggregated ES values at a stakeholder group level to analyze if and how perceptions of well-being and drivers of change relate to socio-cultural values. We found five main stakeholder groups who used and managed ES: *environmental and local development professionals*, *locals dependent on provisioning ES*, *locals not directly dependent on provisioning ES*, *nature tourists* and *rural tourists*. We found that despite all stakeholder groups sharing similar views on *critical ES* (as described in the first part of the discussion and shown in Fig. 3 and Table 2), there were contrasting perceptions regarding: (1) the vulnerability of other ES (Table 2) and (2) the drivers of change important for the future of the area.

Recent studies have shown that divergent stakeholder priorities, often referred to as value conflicts, can be used to visualize possible trade-offs between different ES, given that people's willingness to conserve one ES might be at the expense of another (Martín-López et al., 2012). First, while every stakeholder group acknowledged the main vulnerable ES, the degree to which they agreed (Table 2) and the bundles of ES that each of the groups perceived to be linked to them considerably differed (Table 2 and Fig. 8), highlighting different dimensions of the land use change processes taking place in the study area. For instance, *environmental and local development professionals* also perceived more *vulnerable but not important* ES (i.e., LEK, soil fertility and aesthetic values) whereas, *locals dependent on provisioning services* and *locals not directly dependent on provisioning ES* tended to focus strongly on the vulnerability of *critical* ES (i.e., provisioning services such as agriculture, livestock and fresh water). Thus, while the *environmental and local development professionals* tended to acknowledge mostly the cultural dimensions of land use change, relating the endangerment of traditional provisioning ES with a loss of LEK and aesthetic values, reflecting the degradation of the cultural landscapes; the *locals dependent on provisioning ES* tended to relate it with the degradation of their livelihoods.

However, value conflicts do not only arise from perceiving different ES but they can also arise when despite valuing the same ES, they differ in content and imply mutually exclusive actions or policies (Trainor, 2006). We found that stakeholder groups strongly differed on the perceptions of the drivers of change relevant in the future of the area (Fig. 7). For instance, *environmental and local development professionals* attached importance to the indirect drivers of change (i.e., the effect of economic development, the implementation of conservation policies and the change of local values) (Figs. 7 and 8). In contrast, *locals dependent on provisioning ES* and *locals not directly dependent on provisioning ES* perceived the importance of the effect of direct drivers of change, particularly those related to intensifying agriculture and water management (i.e., land-use changes, water contamination and water overharvesting) and of technology. Therefore, even when both groups (i.e., *environmental and local development professionals* and *locals*) perceive the same ES as critical (e.g., agriculture and fresh water) they have different perceptions of which are the underlying drivers of change causing their deterioration and the factors that might help to reverse their negative trends in the future. Thus, this translates in ES trade-offs produced by mutually exclusive actions. For example, *locals dependent on provisioning ES* are proposing to modernize the irrigation systems in order to reduce the vulnerability of fresh water caused, in part, by intensification. This action entails the substitution of the traditional acequias system for drip irrigation that works rather with pipes that run underground. On the contrary, *environmental and local development professionals* propose and implement management plans to conserve acequias that are at odds with the strategies supported by *the locals dependent on provisioning ES*.

Finally, the existence of these contrasting values of ES and drivers of change were also linked to some dimensions of human well-being. When we explored the perceptions of well-being we found that items regarding the basic materials for good life, security, health and good social relations had higher appraisals and did not show any significant differences among stakeholder groups (Appendix E). On the contrary, issues regarding freedom of choice and action received lower scores and showed significant differences among stakeholder groups. Thus, the ability to achieve what they value might be influencing what they perceive as relevant drivers of change. This could partly explain that, for instance, *locals dependent on provisioning ES*, who have low influence on decision-making (Fig. 8) and low levels of participation might not perceive, in general, the relevance of some of the indirect drivers of change in the area, for example the conservation policies or local values change. This suggests, as McShane et al. (2011) highlights that, "differences in beliefs and preferences are also often linked to differences in the power to pursue goals or to make ones' voice heard".

Given that one of the most important challenges in ES is managing the emerging trade-offs (Bennett et al., 2009), our results show that socio-cultural valuation can substantially contribute to identify them by focusing on the conflicts that emerge among different stakeholder groups and consequently to analyze how different ES trade-offs affect

them. In line with previous studies, our results confirm that ES values are influenced by stakeholder profiles and backgrounds (type of knowledge they hold, occupation, place of residence) (Hicks et al., 2013; Martín-López et al., 2012; Oteros-Rozas et al., 2014). However, we also suggest that we need to pay more attention to other stakeholders' perceptions like their needs and their influence and power over drivers of change, which ultimately modify ES delivery and ES values.

5.3. Methodological Implications for ES Assessments

The literature has increasingly acknowledged the need to incorporate a wide range of ES in assessments (Seppelt et al., 2011). However, problems still exist on how to prioritize the ES and how to analyze the relationships among them (Mouchet et al., 2014; Raudsepp-Hearne et al., 2010). Our results show that socio-cultural valuation might be a useful tool in the incorporation and prioritization of several ES in the decision-making process for a number of reasons.

First, the socio-cultural valuation performed in this study shows that semi-arid watersheds provide a wide range of ES recognized by the stakeholders. One of the advantages of using socio-cultural valuation is that it does not present the problem of monodimensionality associated with economic metrics and therefore enables the assessment of a broad range of ES. In fact, because the final aim of socio-cultural valuations is not to obtain a final measure of a particular ES but to make explicit stakeholders' interests (Chan et al., 2012), different ES can be analyzed at one time. Furthermore, it might overcome the problems shown with specific economic valuation techniques such as market prices in arid and semi-arid areas where ES relevant to the stakeholders' well-being showed low market values (O'Farrell et al., 2011). Here, the ES perceived as most important for well-being was traditional agriculture, which currently has a marginal economic value because it is mainly a subsistence activity. However, its social importance seems to go beyond its economic value.

Second, we have proved that socio-cultural valuation is a case-sensitive (detects differences in perceptions in different areas) and stakeholder-sensitive tool (detects differences in perceptions among stakeholder groups). In line with this, taking into consideration stakeholders' perspectives might be a useful way to approach ES trade-offs and to explore the potential social conflicts involved in ES management. This means to realize that favoring the supplying of certain ES might affect positively certain ES and therefore specific stakeholder groups but negatively affect others (see Section 5.2 for examples) (Howe et al., 2014). It has been suggested that trade-off thinking, which means focusing not only in win–win solutions but on framing choices as also implying losses for certain groups, allows multiple stakeholders to recognize the hard choices that often have to be made in decision-making (McShane et al., 2011).

However, in order to promote trade-off thinking we argue that linking ES values to other stakeholder perceptions, including well-being and drivers of change, might be a useful way to move forward in ES valuation because it allows to make explicit: (1) context-dependency, as values exist within a specific setting, (2) value conflicts, as different stakeholders might value the same ES but for different purposes or with different decision outcomes and (3) power relations.

However, it must be noted that the specific methodology employed in this study is one of the many methodologies that can be used in socio-cultural valuation, which are yet to be explored (Kelemen et al., 2014). Specifically, qualitative techniques have been less explored in the ES literature. It has recently been suggested that, for example, narrative-based elicitation techniques might be a more suitable approach for some cultural ES (Satterfield et al., 2013) as well as deliberative techniques might allow taking into account different dimensions of values and criteria (Trainor, 2006). Future studies will indeed make possible to further understand ES socio-cultural values and how these relate to stakeholders' needs and priorities (Schröter et al., in press).

6. Conclusions

Our approach shows how socio-cultural assessments can help identifying priority ES for management combining measures of importance and vulnerability from a stakeholder perspective. In our case, *critical* ES (e.g., traditional practices related to provisioning services, fresh water and erosion control), which are highly important for social well-being in the area but also highly vulnerable, could be an important starting point for ES management in the area. However, we suggest that by focusing only in these ESs we might be losing a wider picture regarding the contributions of different ESs to stakeholders' well-being and how different drivers of change might affect ES delivery. In the literature there are constant references to the need of incorporating conflicting values and the needs of multiple stakeholders in decision-making processes from the outset (Whitfield et al., 2011; Whitfield and Reed, 2012). Our results show that socio-cultural valuation might be an important tool in visualizing value trade-offs when linked to stakeholder analysis and thus, help to foster dialogue different stakeholder groups. Lastly, because well-being is at the core of ES definition we believe that a higher emphasis should be made in using techniques that explicitly link ES values to different aspects of well-being and how the decisions that stakeholders make may enhance or reduce it.

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ecolecon.2014.09.028.

Acknowledgments

We are grateful to the people who kindly responded to the questionnaire, to the three anonymous reviewers for their thorough and insightful comments during the revision period, to Erik Gómez-Baggethun for his valuable comments on an early draft of this paper and to Ignacio Palomo for the cartographic work. Support for this research was provided by the Spanish Ministry of Economy and Competitiveness (project CGL2011-30266) and by the Seventh Framework Programme of the European Commission (FP7, 2007–2013) under the OpenNESS Project (EC-308428). Support for Marina Garcia-Llorente is also acknowledged from the Alliance4Universities grant and BESAFE Project funded under the Seventh Framework Programme of the European Commission (EC 282743). Our study is part of the Millennium Ecosystem Assessment of Spain (http://www.ecomilenio.es/) as a local case study.

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