



Impacts of land use change on ecosystem services and implications for human well-being in Spanish drylands



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ABSTRACT

The arid southeastern Iberian Peninsula is a unique region in which conservation and human development have coexisted and coevolved over many decades. However, conflicts between economic development and conservation have generated increasing concern due to the rapid expansion of greenhouse horticulture and the abandonment of rural and mountainous areas. Human decisions regarding land use management have affected the status of ecosystems and therefore the ecosystem services supply. We identified four land use-land cover changes that summarize the most common management decisions. These include greenhouse horticulture expansion, urban intensification, rural abandonment, and conservation actions, which occur through protected area declarations. This study aims to explore the social relevance of land use-land cover changes on the delivery of eight key services provided by Spanish arid ecosystems as follows: provisioning services related to intensive and traditional agriculture, regulating services associated with water regulation, climate regulation, air quality and erosion control, and cultural services linked to local identity and tourism. Through 402 face-to-face questionnaires, we analyzed the arguments for and against these four land use-land cover types. We also assessed their impact on ecosystem services and the social importance and vulnerability of ecosystem services. We found significant differences in the social perception of the positive and negative impacts of land use types on ecosystem services. The sample population recognized the negative impacts of greenhouse horticulture on regulating services that are, in terms of water regulation, essential for the sustained delivery of final provisioning services related to agricultural activities. Overall, traditional agriculture and tourism are recognized as the most important services. A controversy between the two opposite models of territorial development – urban development and nature conservation – highlights the need to promote new strategies of land management. Finally, we discuss the usefulness of this approach to understand the arguments affecting the promotion of land use-land cover changes and to visualize the ecosystem service trade-offs under different management strategies.

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1. Introduction

Land use-land cover (LULC) changes are a driver of global change that directly affects the status and integrity of ecosystems, and in last term its capacity to supply ecosystem services. LULC changes thus merit special attention for land management and planning due to their potentially negative consequences, creating trade-offs between some ecosystem services (Nelson et al., 2010; Pereira et al., 2012). For instance, the urban intensification that has occurred in recent decades has been accompanied by large increases in

resource consumption, habitat fragmentation and biodiversity loss (Foley et al., 2005; Lawler et al., 2014). In other situations, LULC decisions have preserved ecological values and ecosystem services through conservation strategies, including the designation of protected areas (Abram et al., 2014). In this sense, LULC changes affect both habitat characteristics linked to biodiversity and ecosystem services that are vital to the maintenance of human well-being (Foley et al., 2005; Schröter et al., 2005). Often, these decisions create compromises or trade-offs when a given land management strategy enhances the delivery of particular ecosystem services while limiting others (Mouchet et al., 2014). For example, Butler et al. (2011) identified a direct trade-off between food and fiber production versus water quality regulation, and Rodríguez et al. (2006) demonstrated how actions to enhance the supply of food and timber have led to declines in nutrient cycling and flood regulation services. Other authors have identified trade-offs between economic development and the provision of landscape aesthetic value and water supply for human use (Vidal-Legaz et al., 2013).

In this context, management decisions should promote sustainable landscape strategies in which human needs are satisfied while maintaining the capacity of the ecosystem to preserve key ecosystem services (McShane et al., 2011). In fact, several studies have stated the importance of exploring how land management influences the delivery of ecosystem services as different management strategies can change the relationships among ecosystem services, often creating opportunities to promote or deteriorate services simultaneously (Bennet et al., 2009; Mouchet et al., 2014). In this way, the aim of this study was to explore the arguments that support and oppose the promotion of LULC changes, as well as to assess their impact on a variety of ecosystem services provided by arid Spanish ecosystems. The selected ecosystem services included food production from traditional agricultural methods, food production from intensive agricultural methods, air quality, climate regulation, water regulation, erosion control, tourism and local identity.

In the arid ecosystems of the Mediterranean region of south-eastern Spain, the consequences of LULC changes on the capacity of ecosystems to provide services are especially important due to the ecological vulnerability and high biodiversity of these ecosystems (Palutikof et al., 1996; Sala et al., 2000; Lázaro et al., 2001; Spanish NEA, 2014). This area is the driest region in continental Europe (García-Latorre et al., 2001; Armas et al., 2011) and has experienced one of the most dramatic and significant LULC transformations in all Europe, with enormous economic and socio-cultural consequences (Aznar-Sánchez et al., 2011; Muñoz-Rojas et al., 2011). It has one of the highest population growth rates in Spain, where immigrants account for 22% of the total population. It also has a birth rate above the Spanish average (Wolosin, 2008; INE, 2011). Since 1960, land-planning strategies to promote socio-economic development in this area caused four policy-based main LULC changes: (1) a rapid transition toward intensive greenhouse horticulture in coastal areas (representing 3.15% of the study area surface) (UNEP, 2005; Aznar-Sánchez et al., 2011) promoted by the National Institute of Rural Development and Colonization (Royal Legislative Decree 24/06/41); (2) urban expansion associated with population growth produced by agriculture intensification and massive tourism along the coastline (2.65% of the study area surface) promoted by the Andalusian Law 7/2002 in Urban Planning; (3) rural abandonment produced by the exodus of people toward urban areas along the coast (44.52% of the study area surface), which is currently combated by the Spanish Law 45/2007 on Rural Development; and (4) the declaration of the protected area networks with the aim of conserving the unique ecological value of this territory (20% of the study area surface), as for example Sierra Nevada National Park (Spanish Law 3/1999) or the Cabo de Gata Natural Park (Andalusian Legislative decree 314/1987) (Fig. 1). Based on these land transformations, particularly related to agriculture

intensification, this period was described as “the Almería miracle” in response to the conversion of the driest regions in Europe into one of the most economically prosperous areas in the country due to the proliferation of greenhouse horticulture (Mota et al., 1996).

In the face of these land use transformation, this study explores the arguments supporting and against these LULC changes, their links with components of human well-being and the drivers of change, and their impacts on ecosystem services supply. More specifically, to understand the factors behind the promotion of LULC changes in the study area, we (1) identified the arguments for and against the promotion of each LULC type, (2) analyzed the social perception of the impacts of LULC on eight ecosystem services provided by the region, and (3) explored the social importance and perceived vulnerability of ecosystem services. Our research contributes to an improved understanding of the relationships between LULC transformation and human well-being and the interaction between LULC changes and ecosystem services. Finally, we discuss how the results support specific targets of existing European policies in terms of the legal framework and strategies to enhance biodiversity (Spanish Law 42/2007 on Natural Heritage and Biodiversity) and rural development (Law 45/2007 on Rural Development), and how they can contribute to promote new sustainable land management strategies.

2. Study area: arid ecosystems of the Iberian Peninsula and the occurring LULC changes

The study area is located predominantly in the Almería province and, to a lesser extent, in the Granada province, covering approximately 1,220,711 ha (Fig. 1). The mean annual temperature in the region varies from 12 to 18 °C, and the annual precipitation is below 350 mm/year in most of this territory (Armas et al., 2011). This region is distinguished by the presence of arid landscapes and diverse land use types.

Over the last 50 years, this arid region has experienced one of the largest LULC changes in the territory, which has been driven by the introduction of intensive greenhouse agricultural practices. Before 1960, this area was described as one of the poorest provinces in Spain (Sánchez-Picón et al., 2011). Historically, the conditions for human occupancy have been unfavorable, marked by scarce rainfall, rough land and frequent strong winds (Wolosin, 2008). The development model was fundamentally limited by water scarcity, and it was dedicated to subsistence agriculture characterized by dry farming with low yields. It was not until 1970 that this socio-economic model changed, led by the development of intensive agriculture, the tourism sector and the construction industry (CAMP, 2013). From 1982 to 2003, this region developed into the major producer of vegetables for Spain and other European Union countries. The region now holds the largest concentration of greenhouses in the world (approx. 26,750 ha) and is known as *El Poniente* (UNEP, 2005) and *The Plastic Sea* of Almería (Aznar-Sánchez et al., 2011) (Fig. 2A and B). The rapid development of this sector was fueled through the use of groundwater (and later desalinated sea water), the introduction of innovative technologies (such as biological control), the high number of sunny hours and the absence of a true thermal winter (CAMP, 2013).

As a result of the promotion of agricultural intensification, the area experienced a population boom coupled with the development of urban areas. On the one hand, the increasing population led to a rise in urban intensification in littoral areas and converted the Almería province into one of Spain's most transformed provinces. On the other hand, this urban intensification, coupled with the lack of employment in rural areas and the low profits from the traditional agriculture, provoked the migration of people from rural areas to urban areas in search for better opportunities.

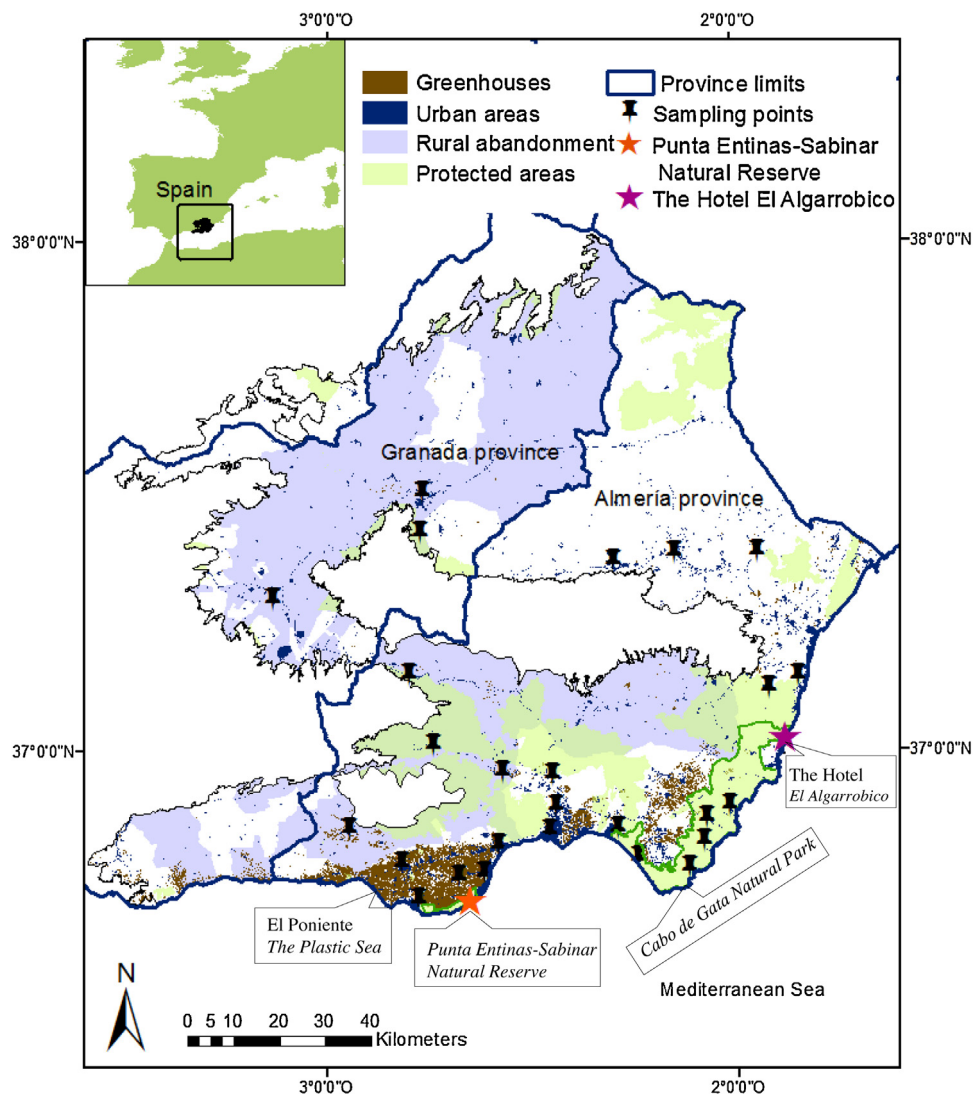


Fig. 1. Location of the study area, spatial distribution of the land use-land cover (LULC) types, and sampling points.

Subsequently, this promoted the depopulation of rural areas and the resulting abandonment of traditional agriculture (EEA, 2010; Fischer et al., 2012; Iniesta-Arandia et al., 2015), causing a subsequent loss of traditional crops (Appendix A).

Concurrent with these extensive land transformations, there has been a simultaneous effort to protect natural areas with unique biodiversity (Hose, 2007). As a result, 30 protected areas have been declared in last three decades, converting the percentage of conserved land surface from 4% to 20%. Examples of this conservation effort include the declaration of Cabo de Gata Natural Park in 1987 and the Sierra Nevada National Park in 1999. Currently, the percentage of protected areas within the study area is above both the average for Andalusia region (19.86%) and Spain (12.85% of surface protected).

3. Methods

3.1. Data sampling and questionnaire design

From February to April 2012, we conducted face-to-face questionnaires with local residents. Overall, 402 valid questionnaires were completed and used in this study (Fig. 1). Social sampling was conducted at 26 different sampling sites, and the population sampled was randomly selected. Sampling covered a wide

range of stakeholder backgrounds, involving residents working in the primary sector, such as farmers (both from greenhouses and traditional practices), housewives, workers in the tertiary sector, and workers in public administration. The questionnaires collected information regarding (1) the arguments for and against of LULC types, (2) the perceived impact of LULC types on ecosystem services, (3) the perceived importance and vulnerability (increase, stable or decrease) of ecosystem services, and (4) the socio-demographic information of area residents.

We asked respondents to provide arguments for and against each LULC type using panels illustrating the four LULC types to facilitate their understanding (see Appendix A; REDIAM, 2007). We made no effort to force people to provide arguments; respondents were given the option to not provide an argument if they did not recognize any (Sherren and Verstraten, 2013). This was conducted to consider only the arguments for which the respondents had a formed an opinion of the topic. From the narratives and an analysis of the words in the description provided by the respondents, we identified several main topics. We then developed initial categories for these topics and grouped similar arguments by each LULC type identifying the most representative categories. Based on Palomo et al. (2013) and using the conceptual framework of the Millennium Ecosystem Assessment (MA, 2005) and the Spanish National Ecosystem Assessment (2014), we related the arguments

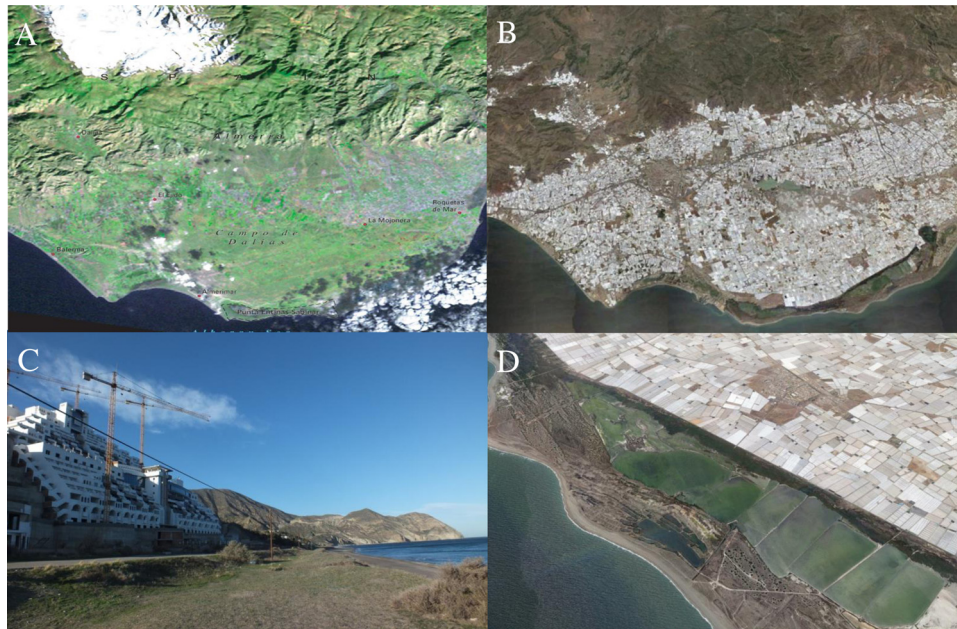


Fig. 2. Examples of the main land use-land cover (LULC) changes that occurred in the study area. (A) *El Poniente* area in 1970, and (B) the conversion of *El Poniente* into greenhouses in 2006. (C) *El Algarrobrico* hotel within the *Cabo de Gata Natural Park*. (D) *Punta Entinas-Sabinar Natural Reserve* surrounded by the intensively managed landscape of Almería, Spain.

to direct drivers of global change (any factor that directly alters ecosystems, such as land use change, climatic change, pollution, invasive alien species, biogeochemical cycles changes and overexploitation), to indirect drivers of change (such as the demographic, economic, socio-political, science and technology or social factors and processes that act in a more diffuse way by altering ecosystems), and to components of human well-being (the basic material for a good life, health, good social relations, security and freedom of choice and action). Arguments were linked to drivers of change and to components of human well-being if a predominant and explicit relationship was identified. Positive arguments were linked to indirect drivers and human well-being components. For instance, the creation of economic development was linked to economic progress as an indirect driver and to the production of basic material for a good life as a human well-being component (Table 1). However, negative arguments were linked to indirect drivers, components of human well-being, but also to direct drivers of change which act as pressures and negative effects. For example, the negative argument of excessive land occupation attached to greenhouse horticulture was linked to the direct driver of change of land use.

Secondly, we explored how respondents interpreted the impact of LULC (either positive or negative) on the ecosystem services. We used eight previously identified key ecosystem services according to their relevance in relation to LULC changes and their ecological characteristics as they related to arid conditions (Castro et al., 2011, 2014; García-Llorente et al., 2012a; Quintas-Soriano et al., 2014). The selected ecosystem services were food production from traditional agriculture, food production from intensive agriculture, air quality, climate regulation, water regulation, erosion control, tourism and local identity (see Appendix B for a full description of the ecosystem services).

Finally, the respondents were asked to choose two ecosystem services that were positively impacted by each LULC type and two that were negatively impacted. In total, the respondents chose a maximum of 4 ecosystem services that were impacted for each LULC. Additionally, the respondents assigned an intensity score for each impact ranging from 1 (minimum intensity) to 10 (maximum intensity). Unselected ecosystem services were rated as neutral.

We then used spider diagrams to compare the positive and negative impacts of each LULC type on the ecosystem services supply. Differences between the perceived impacts of the LULC on ecosystem services were explored using a non-parametric Kruskal–Wallis statistical test. Finally, the respondents were asked to indicate the relative importance and perceived trend (decrease, increase or no change) of each ecosystem service. To do this, they were asked to select from the panel the four ecosystem services most important to them (Appendix B). They then indicated the trend of each ecosystem service over the past 10 years. All statistical analyses were performed using the software package XLSTAT 2010.

4. Results

The average age of the respondents was 40.88 years, and there was an almost even distribution between the male and female respondents (53.98% male and 46.02% female). The sample included respondents working in the agricultural industry, the public administration sector and housewives among others. Most of the respondents had reached professional or university-level education (34.08% and 33.08%, respectively), and 42.79% of respondents had a monthly income under 900€. The respondents presented an active interest in nature with respect to recycling habits (52.49% of the respondents reported that they always or almost always recycle) and an interest in the protected areas, which they frequently reported visiting within the previous year.

4.1. Arguments for and against each LULC

Protected areas were the LULC type that garnered the most social support (71.64% of the respondents expressed positive arguments for this LULC), followed by greenhouse horticulture (69.15%), urban intensification (55.22%), and rural abandonment (24.88%). The LULC urban intensification had the greatest number of arguments against it (74.88% of the respondents expressed negative arguments for this LULC), followed by greenhouse horticulture (69.67%), rural abandonment (35.91%) and protected areas (31.84%). Table 1 summarizes the variety of arguments for and against each LULC, as

Table 1
Arguments for and against each land use-land cover (LULC) type, number of respondents mentioning each argument (expressed as the percentage of the total respondents), related direct drivers (land use change, climatic change, pollution, invasive alien species, biogeochemical cycles changes, and overexploitation) and indirect drivers (demographic, economic, sociopolitical, science and technology, cultural and gender drivers), and components of human well-being (basic material for a good life, health, security, good social relations, and freedom of choice and action).

Arguments	Frequency (%)	Direct drivers (predominant)	Indirect drivers (predominant)	Human well-being (predominant)
Greenhouse horticulture				
In favor (69.15%)				
Promotion of employment and lifestyle	42.09		Economic	Basic material for a good life; security
Creation of economic development	28.06		Economic	Basic material for a good life; security
Increasing farming productivity	12.23		Economic	Basic material for a good life; security
Obtaining products out of season	9.71		Science and technology	Basic material for a good life
Against (65.67%)				
Pollution (burning agricultural plastics and chemical contamination)	30.30	Pollution		Health
Aesthetic impact	16.21	Land-use change		
Ecological impact	9.85	Land-use change		Health; security
Excessive land occupation	6.82	Land-use change		
Social inequality and worker overexploitation	6.06		Demographic; sociopolitical; cultural	Freedom of choice and action
Soil erosion	4.55	Climatic change		Security
Urban intensification				
In favor (55.22%)				
Promotion of employment	42.79		Economic	Security
Creation of housing	17.57		Economic; demographic	Basic material for a good life; security
Creation of economic development	13.96		Economic	Basic material for a good life; security
Promotion of human well-being	9.46		All	All
Increasing tourism	6.31		Economic; cultural	Good social relations; freedom of choice and action
Increasing population	5.41		Economic; demographic	
Against (74.88%)				
Uncontrolled urban expansion and housing oversupply	45.85	Land-use change	Demographic; socio-political; economic	Security
Corruption and speculation	20.93		Socio-political; economic	Basic material for a good life
Ecological impact	11.30	Land-use change	Demographic; economic; socio-political	Health; security
Aesthetic impact	4.98	Land-use change	Demographic; economic; socio-political	
Overpriced housing	4.65		Economic	Security
Soil loss	3.32	Land-use change	Demographic; economic; socio-political	Health; security
Rural abandonment				
In favor (24.88%)				
Search for job opportunities	34.00		Economic; cultural	Security; freedom of choice and action
Life quality improvement	27.00		Economic; demographic	Security; freedom of choice and action
Restoration of natural environment	13.00			Health
Against (35.91%)				
Loss of local identity and local ecological knowledge	41.32		Cultural; science and technology	Good social relationships
Rural depopulation	16.17	Land-use change	Demographic; economic; cultural	Good social relationships; security
Crop abandonment	11.98	Land-use change	Economic; cultural	Basic material for a good life; health
Protected areas				
In favor (71.64%)				
Environment conservation and biodiversity protection	64.93		Socio-political; cultural	Basic material for a good life; health
Promotion of human well-being and health	9.38		All	All
Increasing tourism	10.75		Economic; cultural	Good social relations; freedom of choice and action
Against (31.84%)				
Excessive legislation and banning	35.94	Land-use change	Socio-political	Freedom of choice and action
Limitation of human development	21.88	Land-use change	Socio-political; economic	All

Table 2

Kruskal–Wallis test and Dunn groups to compare the impact of land use–land cover (LULC) on ecosystem services. Letters in parentheses represent statistically different groups as identified by the Dunn test. In bold the most remarkable results.

	Traditional agriculture	Intensive agriculture	Air quality	Climate regulation	Water regulation	Erosion control	Tourism	Local identity
Greenhouse horticulture	– (B)	+ (C)	– (A)	– (A)	– (A)	– (B)	– (A)	+ (B)
Urban intensification	– (B)	+ (B)	– (A)	– (B)	– (A)	– (A)	+ (C)	+ (C)
Rural abandonment	– (A)	+ (B)	+ (B)	+ (C)	– (B)	– (B)	– (A)	– (A)
Protected areas	– (B)	– (A)	+ (C)	+ (D)	+ (C)	+ (C)	+ (B)	+ (BC)
Kruskal–Wallis test	112.55 ^a	684.23 ^a	389.54 ^a	278.66 ^a	150.09 ^a	242.60 ^a	410.47 ^a	315.65 ^a

^a Statistical significance = 1%.

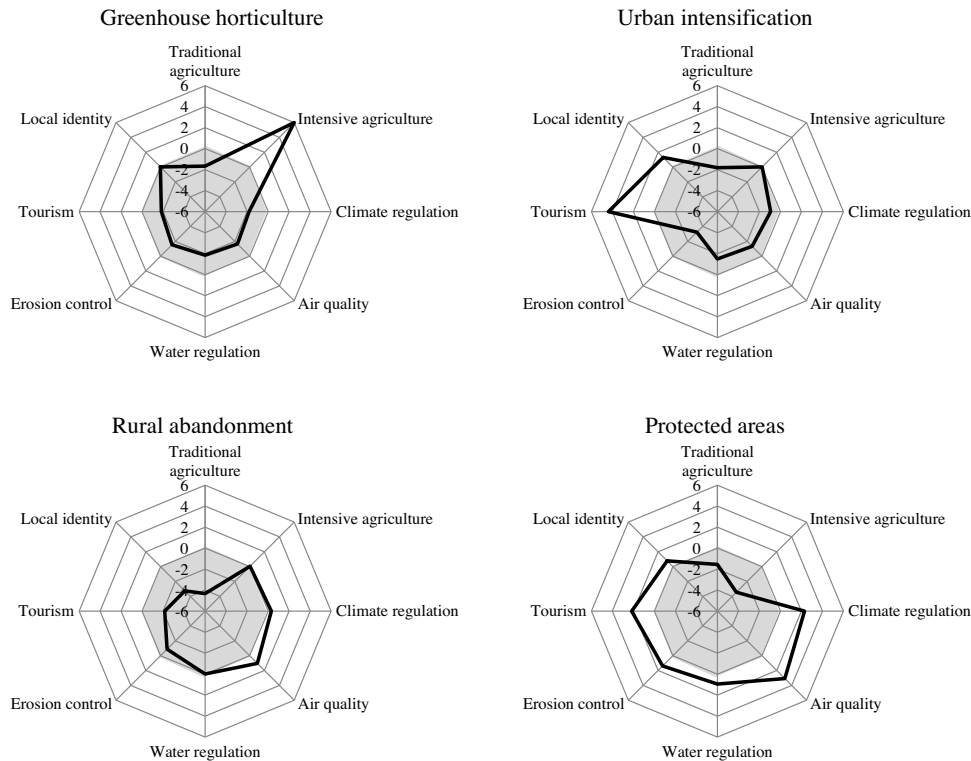


Fig. 3. Perceived impacts of land use–land cover (LULC) types on ecosystem services. The grey area in the spider diagram represents the negative impact, and the white area represents the positive impact.

well as the direct and indirect drivers identified and the related components of human well-being.

The positive arguments for greenhouse horticulture were mostly related to employment and economy. For example, respondents considered this agricultural practice important for the *promotion of employment and lifestyle* (42.09%) and for the *creation of economic development* (28.06%). Some respondents related greenhouse horticulture to the quality and abundance of food, using positive arguments such as *increasing farming productivity* (12.23%) and *obtaining products out of season* (9.71%). These arguments are related to the components of human well-being of basic material for a good life (e.g., acquiring shelter and food) and security, which are promoted by economic development (an indirect driver of change; Table 1). However, other respondents were of the opinion that this greenhouse horticulture was related primarily to a negative environmental impact in the form of *pollution* (both the pollution from burning agricultural plastics and the chemical contamination of soil and water from pesticides; 30.30%), *aesthetic impact* (16.21%), *general ecological impact* (9.85%) and *soil erosion* (4.55%). These negative arguments were mainly related to the direct driver of land use change and their impact on the environment; they were linked to the health component of human well-being. Respondents also visualized negative arguments associated to demographic and

socio-political factors, such as the *social inequality and worker over-exploitation* that occur in the area (6.06%).

Respondents identified similar positive arguments for urban intensification linked to economic factors, such as its contribution to the *promotion of employment* (42.79%), *creation of housing* (17.57%), *increasing tourism* (6.31%) and *increasing population* (5.41%). Other arguments mentioned this in a general way (referencing the *creation of economic development*, with 13.96% of the respondents expressing positive arguments for this LULC, or the *promotion of human well-being* with 9.46% of the respondents using this argument), linked to the basic material for a good life and security as components of human well-being (Table 1). However, most of the respondents considered economic and socio-political drivers to be the main factors responsible for *corruption and speculation* in the political arena (16.94%), *uncontrolled urban expansion and housing oversupply* (45.85%), and *overpriced housing* (4.65%) (Table 1). These drivers were mainly related to environmental problems produced by urban intensification in terms of *ecological impact* (11.30%), *soil loss* (3.32%) and *aesthetic impact* (4.98%).

Positive arguments associated with rural abandonment were related to the search for improved well-being in other areas (but not to the positive aspects of rural abandonment itself). These were mainly the *search for job opportunities* (34%) and *life quality*

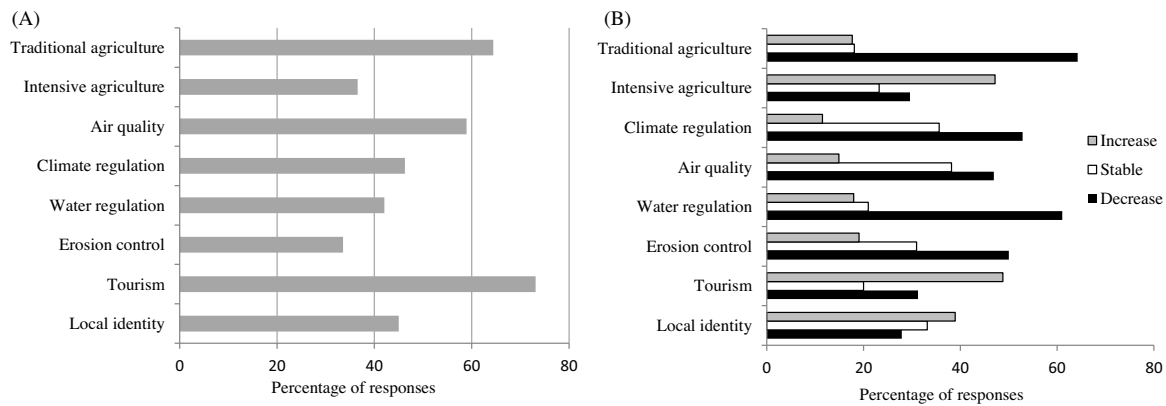


Fig. 4. (A) Social importance and (B) trend of ecosystem services (increase, stable or decrease).

improvements (27%). These arguments seemed to be driven by indirect demographic and economic drivers and mostly referred to the human security and freedom of choice and action as components of human well-being. Positive arguments were also connected to the restoration of natural environment (13%) due to the migration of the local population. On the contrary, negative arguments related to this LULC included references to rural depopulation (16.17%) linked to the loss of local identity and local traditional knowledge (41.32%) and the loss of traditional crops or crop abandonment (11.98%) (Table 1). These negative arguments were connected to the indirect demographic driver of change.

Finally, the importance of nature conservation to the respondents was evidenced by the positive and conservational arguments found according to this LULC type (e.g., environment conservation and biodiversity protection; 64.93%). In addition, the respondents linked protected areas with the promotion of human well-being and health (9.38%) and with the economic benefits of tourism (6.94%). These positive arguments were linked to the components of human well-being of basic material for a good life and health (Table 1). In contrast, restrictive protection within these areas included negative arguments that were interpreted in terms of limiting human activity (e.g., the excessive legislation and banning (35.94%) and the limitation of development and activities (14.06%)) and were related to their effects on the freedom of choice and action of human well-being. These negative arguments are connected to socio-political and economic drivers of change.

4.2. Perceived impacts of LULC on ecosystem services

We found significant differences among the perceived impacts of all LULC on the eight ecosystem services (Table 2). Respondents perceived greenhouse horticulture impacting all ecosystem services negatively, with the exception of intensive agriculture service, which was impacted positively. In particular, water regulation and climate regulation were the services perceived as most negatively impacted (Fig. 3).

Similarly, respondents recognized the negative impact of urban intensification on regulating services, such as climate regulation, air quality, water regulation and erosion control, and on traditional agriculture. In fact, urban intensification was the perceived LULC that affected erosion control most negatively (Table 2; Fig. 3) but had the highest positive impact on tourism.

Rural abandonment was linked to the maintenance of ecological processes, positively impacting regulating services but also negatively impacting traditional agricultural practices. We found significant differences showing that rural abandonment was the LULC with the most negative impact on traditional agriculture and local identity (see Table 2). Moreover, respondents perceived nega-

tive impacts on cultural services and on erosion control associated with the abandonment of agricultural traditional practices that are used for soil conservation, such as terracing (Fig. 3).

Conversely, protected areas were perceived as providers of regulating services, especially air quality, climate regulation and erosion control. However, protected areas were also perceived as a barrier to provisioning services delivery, particularly intensive agriculture, due to the restrictions of extractive uses within these areas in terms of agricultural products (see Table 2).

4.3. Preferences and perceived trend of ecosystem services

Tourism (73.13% of respondents selected it as important), traditional agriculture (64.43%) and air quality (58.96%) were considered to be the most relevant services. Meanwhile, erosion control received the lowest recognition (33.58%); followed by intensive agriculture (36.58%) (Fig. 4A). Other ecosystem services had average values of importance.

Many of the respondents perceived that regulating services (air quality, climate regulation, water regulation and erosion control) had decreased in the last decade, affecting the capacity of arid systems to provide these services, whereas cultural services (tourism and local identity) were perceived as having a positive trend. Regarding provisioning services, traditional agriculture was perceived mainly as decreasing, whereas intensive agriculture was perceived as increasing (Fig. 4B). In this way, tourism was a socially relevant service experiencing an increase in the area. However, other socially relevant services, such as traditional agriculture and water regulation, were in a vulnerable state, perceived as decreasing in the last years.

5. Discussion

Currently the links between ecosystem services and land use changes are emerging as a way to better understand the dynamics of coupled human and natural systems (Fu et al., 2015). Most of the previous research has focused principally on quantifying biophysical changes in ecosystem services supply under different land use scenarios (e.g., Muñoz-Rojas et al., 2011; Felipe-Lucia et al., 2014; Lawler et al., 2014; Queiroz et al., 2015). However, a current challenge involves analyzing the links between ecosystem services supply and both drivers of change and human well-being (Pereira et al., 2005). This study takes a step forward in the analysis of these relationships by exploring (1) the links between specific LULC types and ecosystem services (e.g., the relationship between protected areas and regulating services) and (2) social arguments behind the changes in land use and their implications for human well-being (e.g., relationship between greenhouse horticulture and the cre-

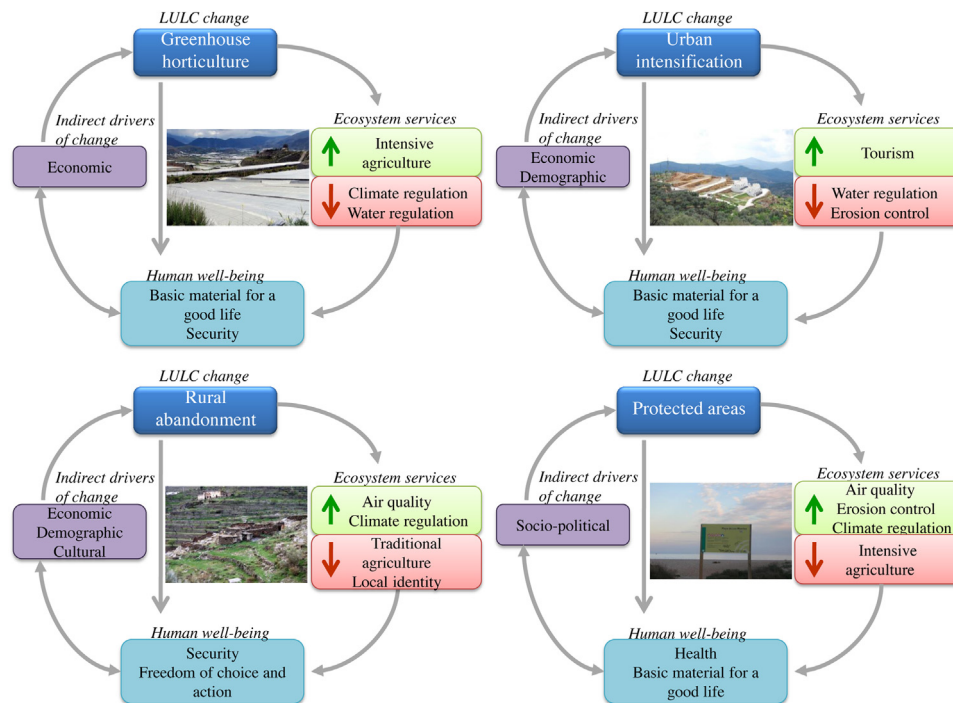


Fig. 5. Links between the perceived impacts of ecosystem services, the indirect drivers of change and the components of human well-being for each LULC type. Only the main impacts of the ecosystem services and the main indirect drivers of change were included.

ation of employment) (Fig. 5). Linking these two inputs allows us to visualize more explicitly the potential trade-offs that practitioners must take into account in order to better understand the complexity behind the promotion of diverse land management policies. Recognizing this complexity is key to understanding not just the ecological and social implications of different land-based policies, but also to providing evidences of synergies and mismatches between coupled human and natural systems (Castro et al., 2016).

At the same time, taking into account the social perspectives of local residents can lead to higher quality and more reliable environmental decision making (Davies et al., 2015). Future management policies should link human well-being with the ecosystem services enhancement, taking into account social perspectives to obtain more adaptive policies. In this way, based on the decisions made on LULC and their impact on the ecosystem services, it is essential to manage ecosystems and to create future economies that foster both sustainable ecosystem services supply use and the promotion of human well-being (Reyers et al., 2009).

5.1. Understanding arguments on LULC changes

In the Mediterranean region, two contrasting trends in LULC changes have been identified over the last several decades (Ruiz-Benito et al., 2010). First, industrial development, which is an intensification of agricultural practices and urban expansion, is reshaping the landscape (e.g., Gulinck et al., 2001; Antrop, 2004). Second, a concurrent increase in the abandonment of rural areas has led to a decrease in traditional agricultural practices. Both processes feature heavily in the case study (García-Llorente et al., 2012b; Stellmes et al., 2013) and are identified as the key drivers of global change (Spanish NEA, 2014).

One of the most recognizable land transformations on a global scale is the high concentration of greenhouse horticulture located in the study area (Aznar-Sánchez et al., 2011; Aguilar et al., 2015). This area has become the largest producer of vegetables at the European

level, becoming the basis of the regional economy and increasing the local standard of living (Mota et al., 1996). This land transformation is socially supported by its links with improvements in quality of life and economic development (Figs. 2 A and B and 5). Respondents linked the economic profits provided by greenhouse horticulture with human development as this economic driver provides stability and security and the basic material for a good life through factors such as income security, tranquility and safety (Fig. 5). However, the respondents also reported several perceived negative impacts of greenhouse horticulture on nature, such as *pollution, ecological impact and aesthetic impact*, as shown in previous studies (Zalidis et al., 2002; Dale and Polasky, 2007; Muñoz et al., 2008; García-Llorente et al., 2012b). This was consistent with findings of Pereira et al. (2005), who reported that respondents involved in agricultural landscapes considered the quality of food to be lower due to the use of chemicals and pesticides. We also observed a similar number of positive and negative arguments (68.17% versus 66.88%, respectively) describing the controversy and complexity of greenhouse horticulture and the challenge of making this LULC type more sustainable. As García-Llorente et al. (2015) state, changing the focus of intensive agriculture from the maximization of food production to the production of food combined with other ecosystem services could help to increase social-ecological resilience (Gordon et al., 2010) and to promote the viability of rural areas through the diversification of the services provided (Power, 2010; Di Iacovo et al., 2014).

The economic transformation promoted that the Almería province as became into one of the most transformed regions in all Spain in terms of urban expansion and construction. Indeed, this region has the largest number of housing units built in Spain (Gonzalez and Ortega, 2009). Urban expansion has fostered an explosion of *sun and beach tourism* at the southwest of the study area (a sort of tourism that takes place on coastlines, where tourists usually sun bathe during the day), where there is a lack of environmental regulation which has been promoted by short-term policies of urban development (Vivas-Puig, 2007). Similar trends

have been found in other Spanish regions, including the mountainous regions of Madrid (Hewitt and Escobar, 2011) and the coastal areas of Barcelona (Dupras et al., 2015). Arguments supporting urban expansion note that people clearly perceive the economic benefits associated with construction and urban intensification (Martín-García, 2007), specifically the increase in job opportunities in the construction sector (see Table 1). However, there is a growing negative perception toward urban intensification and the speculative property bubble linked with corruption and speculation issues in the policy arena (for example, see arguments regarding *uncontrolled urban expansion and housing oversupply, corruption and speculation and ecological impact*). This issue has been widely documented in Spain in previous studies (Romero et al., 2012; García-Quesada et al., 2015), in which people reported being very concerned about illegal practices in the rezoning of lands favorable to construction. This is likely why the respondents perceived political corruption as an important problem associated with urban development in Spain (Jiménez et al., 2014; Villoria et al., 2014), with economic and socio-political indirect drivers behind this LULC intensification. An example of this are the complaints made in the study area over the last 15 years by non-governmental environmental organizations, such as Greenpeace, denouncing the construction of the hotel *El Algarrobo*, which was built within the boundaries of *Cabo de Gata Natural Park* (see Figs. 1 and 2 C) (Garrido Cumbreira and López Lara, 2010). This hotel exemplifies the conflicting interpretation of the environmental Andalusian Law 2/1989 from different administrative scales and social sectors: the regional government's Network of Protected Areas declared this area to be a Natural Park, thus restricting any human development, whereas the economic need of the local municipalities often supersedes such environmental protection and is used to justify intensive development at the expense of ecosystem integrity.

Our results show a general consensus regarding the negative opinions of the effects of rural abandonment on ecosystems. This was shown by the type and number of arguments (41.50% against, versus 24.51% in favor) related to the importance of cultural and traditional values of rural lands. In previous studies, rural abandonment has been visualized as a means of recovering natural environments and as an opportunity to re-wild abandoned areas (Navarro and Pereira, 2012). However, in the Mediterranean, rural abandonment is more often related to the loss of multifunctionality and a less diverse flow of ecosystem services, such as the loss of local ecological knowledge, erosion control and water regulation (Altieri and Toledo, 2005; Blondel et al., 2010; Arnaez et al., 2011; García-Llorente et al., 2012b; Iniesta-Arandia et al., 2015). Today, one of the major problems facing the Mediterranean region is widespread land abandonment (Weissteiner et al., 2011), which is due to a dwindling and aging rural population, resulting in fewer job opportunities and the continuous emigration of young people from this area (Spanish NEA, 2014). All of these processes have reinforced the abandonment trend, resulting in the disappearance of the rural community and its associated traditional knowledge and cultural heritage, leading to the overall impoverishment of the affected rural areas (Pereira et al., 2005).

Despite the LULC changes, this region has one of the highest proportions of protected areas as 22% of the land is protected compared with 19.86% of the land in the Andalusia region and 12.85% of the land in Spain overall. This highlights the controversy existing in this area between two opposite models of territorial development; whereas there is massive *sun and beach tourism* based on urban intensification, nature conservation represents the dominant land use in the southeastern portion of the study area (Fig. 1). One of the protected areas, the *Cabo de Gata Natural Park*, represents the major tourism attraction in the region, with approximately 300,000 visits in 2009 (Muñoz-Flores, 2011). We identified this point to be a conceptualization of human development based on the creation of

protected areas to both conserve the environment and to promote related economic activities, such as ecotourism. Positive arguments supporting protected areas demonstrate that respondents identify these areas in terms of enjoying healthy environments and nature conservation, leading to *increasing tourism* (Table 1). Whereas in the past, protected areas were mainly designed for conserving scenic beauty and wildlife and ban human activities (Pyke, 2007), recent studies show a different tendency in the way the public perceives protected areas and how the incorporation of ecosystem services could overcome conservation challenges, not just in protected land, but also in surrounding landscapes, making conservation actions more publicly accepted (Armsworth et al., 2007; Palomo et al., 2014a; Castro et al., 2015). However, although the surface of protected areas have increased in recent years, ecosystems continue to be fragmented and degraded (Watson et al., 2014), and the rate of biodiversity loss continues to increase (Pereira et al., 2010). This demonstrates the challenge of managing protected areas as provider of human wellbeing (Castro et al., 2015), in addition to managing these areas for biodiversity conservation. An example of this controversy between development and conservation is the *Punta Entinas-Sabinar Natural Reserve*, which is located within the study area (Figs. 1 and 2D). According to the International Union for Conservation of Nature (IUCN), this area is the most restricted for human use and contains the most well-conserved dune systems in the Iberian Peninsula. However, as a result of subsequent local policies, that promoted greenhouse horticulture and urban development in the surrounding areas, the general public does not perceive the utilitarian value of this protected land and instead it is generally considered as a barrier for economic development (Kuriyan, 2002; Allendorf, 2007). It could be related with the classical island management model followed in protected areas till the 80' where the management of protected areas were not integrated in the territory (Palomo et al., 2014b).

As Pereira et al. (2005) suggested, we believe that developing responses that increase both ecosystem service preservation and human well-being are key to understanding the link among local well-being, ecosystem services trends and drivers of change. Accordingly, to produce effective management, the indirect drivers, such as demographic, economic, socio-political, and cultural factors, merit additional study (Carpenter et al., 2006).

5.2. Social perceptions of ecosystem services: impacts, importance and trends

The analysis of social perceptions has emerged as a first step in the incorporation of social perspectives and stakeholder engagement in environmental management decisions (López-Rodríguez et al., 2015). In fact, social preferences toward ecosystem services are a widely-studied topic (e.g., Castro et al., 2011; García-Llorente et al., 2012a,b; Martín-López et al., 2012). However, to date, the analysis of perceptions has not been linked to LULC types. Results can provide useful information for understanding the complexity of human decisions and the influence of the various LULCs on the deterioration or conservation of ecosystem services. The analyzed social perceptions revealed important trade-offs in the land management, such as the importance placed on traditional agriculture, which is considered to be the second most important ecosystem service (Pereira et al., 2005; García-Llorente et al., 2012a) but is also perceived to have the largest decreasing trend. This decreasing trend is supported by the current management dynamics of the territory, which promotes an increase in intensive agriculture, whereas traditional practices are lost (Weissteiner et al., 2011; Subirós et al., 2015). Interestingly, intensive agriculture is perceived to be a less important ecosystem service but exhibits a significant increasing trend. Although the population has a high level of awareness regarding the ecological impact of greenhouses, the perception

that it is less important could indicate that intensive agriculture is not regarded as an ecosystem service but rather as a benefit of the large amount of human, social and built capital required for its delivery (labor, knowledge, technology, etc.) (Costanza et al., 2014), which comprise the relatively lower contributions of ecosystems, with a lesser dependence on maintaining the ecological processes and structures. Indeed, the social preference toward traditional agriculture rather than intensive agriculture shows the greatest discrepancies in the perceived importance of services between both types. In this way, we can differentiate between the following two agricultural models: (1) a commodity based on the production and sales, with a predominance of markets (horticulture agriculture) (Aznar-Sánchez et al., 2011), and (2) an agricultural system that is understood to be a lifestyle coupled with ecosystem integrity that prioritizes the maintenance of traditional practices, such as terracing and the use of water ditches, to effectively promote regulating services and landscape multifunctionality (Iniesta-Arandia et al., 2015).

The general public recognizes the importance of regulating services but perceives a severe impact and degradation following greenhouse horticulture and urban intensification. This could be explained by the fully invasive character of greenhouse horticulture, which negatively affects key ecological processes, such as water and climate regulation. Tourism is clearly negatively impacted by greenhouse horticulture and rural abandonment. In the case of greenhouses, the decrease in tourism is due to the negative visual impact that it has on the landscape, making views of the region less attractive (García-Llorente et al., 2012b). The explanation for the negative impact of rural abandonment is likely related to the general impoverishment of rural areas. Despite the negative impact on tourism, the respondents considered it to be the most important ecosystem service, with the most positive trend. This result is consistent with findings of Martín-López et al. (2012) and is most likely linked to the role of protected areas in the economy of the study area because it is one of the main economic engines after greenhouse horticulture. Moreover, local identity is favored by all LULC types, except rural abandonment. This is clearly because the consequences of rural abandonment include the impoverishment of the area (with respective consequences for economic power, labor force and infrastructure), a decrease of rural populations, and a relative increase in the percentage of elderly inhabitants in the population (Weissteiner et al., 2011). All of this means that local identity service is not considered to be important and often goes unnoticed. According to Subirós et al. (2015), depopulation also leads to a loss of cultural heritage, not only due to the abandonment of traditional farmhouses (and, therefore, the loss of these architectural values) but also due to the disappearance of traditional economic activities linked to farmhouses.

5.3. Moving forward to policy implications and recommendations for European and Spanish policies and management of ecosystem services

Despite the growing interest in ecosystem services across global science and policy arenas, the application of ecosystem services analysis to management decisions remains unclear, and much of the existing literature does not clarify how the information gathered could be used to inform land policy decisions (Laurans et al., 2013). Recent studies make advances in clarifying how ecosystem service assessments could inform environmental decisions (Carpenter et al., 2009; Schouten et al., 2012; Martínez-Harms et al., 2015), but there are still few studies that provide explicit examples of policy applications. With the aim of identifying implications and recommendations in existing environmental policies, we present how our findings can be integrated in targets or priorities of two European and Spanish policies: on one side the Strategic

Plan for Biodiversity 2011–2020 and the Aichi Targets Natural and the Heritage and Biodiversity Spanish Strategic Program (Spanish Law, 42/2007 on Natural Heritage and Biodiversity); and on the other side the EU's Rural Development Policy and the National Rural Development Programme for Spain (Law 45/2007 on Rural Development) (Table 3).

Following the European legislation, by 2020, ecosystems and their services should be maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems (Secretariat of the Convention on Biological Diversity, 2010). In this regard, ecosystem services assessments could be directly implemented in terms of landscape planning instruments to prevent degradation of rural areas characterized by multifunctional agriculture by enhancing its capacity to supply ecosystem services and be designated as high nature value farmland areas¹ (dealing with Target 2 of the European Level; Table 3).

In relation to the Spanish national goal 1 (“obtain the best knowledge for the conservation and sustainable use of biodiversity and ecosystem services”), this study contributes by improving the knowledge on the social perception of the key ecosystem services provided by arid systems and their vulnerability based on different land management decisions and to goal 5 (“establish as a priority element the promotion of responsibility, social participation and social involvement”) by exploring the diverse knowledge of different stakeholders such as local residents, which have been identified as essential for the successful incorporation of ecosystem services into conservation actions (Martínez-Harms et al., 2015; Castro et al., 2016). This study includes the voice of local communities, so it may serve as a starting point for engaging the general public through public participation and later awareness-raising campaigns. For instance, arguments and perceived negative impacts placed on tourism by rural abandonment indicate directions on how future policies must integrate tourism and conservation actions of rural areas and multifunctional landscapes. In the same way, arguments against protected areas (such as *the excessive legislation and banning and limitations of human development*; see Table 1) must be understood as a gap in connecting the services provided by protected areas and human well-being maintenance. Our study shows how the loss of local environmental knowledge is overall identified as a priority for local communities. This result supports the creation of an inventory of traditional knowledge, such as the one recently conducted in Spain (Pardo de Santayana et al., 2014). Also, to preserve and maintain cultural heritage associated to Spanish drylands, we suggest that these results can help the promotion of the collection of memory of the traditional ecological knowledge, acknowledging them as an important part of their cultural heritage at the regional level.

Secondly, one of the most relevant priorities of the EU's Rural Development Policy program is “restoring, preserving and enhancing ecosystems related to agriculture and forestry” (Priority 4; Table 3). At the Spanish level, the National Rural Development Program establishes as a priority 4A “restoring, preserving and enhancing biodiversity, agricultural systems of high natural value and the state of European landscapes” (European Commission, 2015). Regarding this, the importance identified of rural areas and the social concern of the loss of traditional agriculture (Table 1), considered as one of the most important ecosystem service, can be used for putting in value and revitalizing these areas. On the other side, priority 6B of the National Rural Development Programme is to “promote the enhancement of natural and cultural heritage as a factor of sustainable development” (Table 3). We suggest that this research can

¹ High nature value farming describes farming systems in Europe of greatest biodiversity value which are inherently valuable for biodiversity and forms a living cultural and natural heritage (Keenleyside et al., 2014).

Table 3
Policies regulation at European and Spanish levels and the contributions of this study.

Policy target	Policy regulation at European level	Spanish policy regulation	Contributions of this study
Biodiversity conservation	Strategic Plan for Biodiversity 2011–2020 and the Aichi Targets TARGET 2: To maintain and enhance ecosystems and their services TARGET 3: To increase the contribution of agriculture and forestry to maintaining and enhancing biodiversity	Natural Heritage and Biodiversity Spanish Strategic Program (Law 42/2007 on Natural Heritage and Biodiversity) GOAL 1: To obtain the best knowledge for the conservation and sustainable use of biodiversity and ecosystem services GOAL 5: To promote the social participation in the biodiversity conservation and promote their awareness and commitment	<ul style="list-style-type: none"> • To improve the knowledge of linkages between ecosystem services and land uses • To inform environmental policies • To highlight the social recognition of the local ecological knowledge and local identity in rural areas which provide the evidence of social support needed to create the Spanish Inventory of Traditional Knowledge^a • To prevent degradation of rural areas characterized by multifunctional agriculture by enhancing their ecological values and designing high nature value farming areas
Rural development	EU's Rural Development Policy PRIORITY 4: Restoring, preserving and enhancing ecosystems related to agriculture and forestry PRIORITY 6: Promoting social inclusion, poverty reduction and economic development in rural areas	National Rural Development Program for Spain (Law 45/2007 for Sustainable Rural Development) PRIORITY 4A: To restore, preserve and enhance biodiversity, agricultural systems of high natural value and the state of European landscapes PRIORITY 6B: To promote local development in rural areas: promoting the enhancement of natural and cultural heritage as a factor of sustainable development	<ul style="list-style-type: none"> • To improve existing methods to conduct socio-cultural assessment of services in arid systems • To identify public arguments to establish high nature value farming areas which preserve multiple ecosystem services in rural areas • To facilitate the baseline information for a later participatory process to co-design public policies through a multi stakeholder governance focusing in local communities

^a The Spanish Inventory of Traditional Knowledge has been recently published ([Pardo de Santayana et al., 2014](#)).

promote participatory process to co-design public policies through the incorporation of multi-stakeholder governance focused on local communities that promote the restoring of agricultural systems and the enhancement of natural and cultural heritage.

6. Conclusions

In this study, we undertook an analysis of the positive and negative arguments perceived regarding LULC changes. Specifically, we explored the arguments in conflicts related to the LULC planning strategies that occurred in Spanish arid ecosystems and the social relevance of LULC changes on the delivery of key ecosystem services. The impact of land management decisions on the ecosystem services were analyzed, highlighting the difficulty in facing the binomial relationship between development and conservation. Overall, the respondents were aware of the important impacts and trade-offs related to the LULC changes that occurred but prioritized their well-being based on economic arguments. We believe it is critical to pay attention to societal perceptions driving management decisions because these allow us to explore the

relationships between LULC changes and available ecosystem services. Moreover, the controversy existing in this area between two opposite models of territorial development emphasizes the need to promote new strategies for land management. Therefore, analyzing the arguments underlying the specific LULC strategies can help us to adopt specific policies to improve upon current decision-making strategies and include ecosystem services in land decisions and management.

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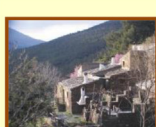








Appendix A.

Panel of land use-land cover used for the social sampling. Maps represent the areas covered by the greenhouses dedicated to the intensive agriculture, urbanized surfaces, natural areas declared under protection and rural abandonment in terms of the rural municipalities categorized as priority areas to be revitalized by Spanish legislation (*Law 45/2007*; *MARM, 2010*).

Land use-land cover	Photo	Map
<p>Greenhouse horticulture</p> <p>Greenhouse horticulture constitutes one of the main land transformations in all of Europe. In fact, the area called “<i>El Campo de Dalías</i>” contains 50% of the greenhouses of the South of Iberian Peninsula. The surface of greenhouses has increased 2% in the last 50 years.</p>		
<p>Urban intensification</p> <p>Almería is one of the regions with the highest land transformation produced by construction, mainly located on the coast. Specifically the surface of urban areas has increased by 2.5 % since 1956.</p>		
<p>Protected areas</p> <p>The protected surface area in Almería province has increased in the last 50 years from 4% to 22%.</p>		
<p>Rural abandonment</p> <p>In Spain the rural areas occupied more than 80% of the surface and only 18% of the population lives in them. In Almería, the rural population decreased from 72% in 1910 to 22% in 2001.</p>		

Appendix B.

Panel of ecosystem services used for social sampling.

Contributions or benefits that nature provides from his biotic and geotica structure and in relation with the material needs or PROVISION of goods			Contributions or benefits that nature provides indirectly through the REGULATION of the ecologic processes			Contributions or benefits that nature provides by the direct contact and related with CULTURAL aspects		
Benefit	Example	Photo	Benefit	Example	Photo	Benefit	Example	Photo
Traditional agriculture (crops, smallholdings, ecologic agriculture)	Olives, almonds, vines, cereals, fruit		Climate regulation through the carbon sequestration	Role of the forest in the temperature regulation or thermal buffer through the CO ₂ sequestration		Tourism	Ecotourism, beach tourism, rural tourism	
			Air quality through the carbon gains	Role of the vegetation in the maintaining of the air quality retaining gases like CO ₂ or other particles pollutants				
Intensive agriculture (mono-cultures, plastics/greenhouses)	Pepper, tomato, melon, watermelon, zucchini		Water regulation	Permeability of soils and dense plant roots that favor the water infiltration and recharge of aquifers		Local identity/ Sense of place	Sense of place associated by the interaction with the nature and the cultural aspects	
			Soil protection/ erosion control	The terrace zones control the landslides and maintaining a stable soil				

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Appendix C. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.landusepol.2016.03.011>.

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