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Research article

Integrating knowledge exchange and the assessment of dryland management alternatives – A learning-centered participatory approach

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ABSTRACT

The adoption of sustainable land management strategies and practices that respond to current climate and human pressures requires both assessment tools that can lead to better informed decision-making and effective knowledge-exchange mechanisms that facilitate new learning and behavior change. We propose a learning-centered participatory approach that links land management assessment and knowledge exchange and integrates science-based data and stakeholder perspectives on both biophysical and socio-economic attributes. We outline a structured procedure for a transparent assessment of land management alternatives, tailored to dryland management, that is based on (1) principles of constructivism and social learning, (2) the participation of stakeholders throughout the whole assessment process, from design to implementation, and (3) the combination of site-specific indicators, identified by local stakeholders as relevant to their particular objectives and context conditions, and science-based indicators that represent ecosystem services of drylands worldwide. The proposed procedure follows a pattern of eliciting, challenging, and self-reviewing stakeholder perspectives that aims to facilitate learning. The difference between the initial baseline perspectives and the final self-reviewed stakeholder perspectives is used as a proxy of learning. We illustrate the potential of this methodology by its application to the assessment of land uses in a Mediterranean fire-prone area in East Spain. The approach may be applied to a variety of socio-ecological systems and decision-making and governance scales.

1. Introduction

Drylands face multiple stresses and challenges that result from the interplay of climate-related and human-induced pressures. Current global changes, including climate change and increasing resource use by an expanding human population, further exacerbate the impact of these pressures on dryland systems, leading to land degradation (MA, 2005; Low, 2013). Furthermore, dry climate types are projected to expand under the influence of ongoing climate change (Feng et al., 2014). Responding to these pressures requires actions at multiple levels. At the local scale, the adoption of sustainable and adaptive management strategies and practices is the critical challenge (Poulsen, 2013), which in turn requires appropriate assessment methodologies (MA, 2005; Zucca et al., 2012) and engagement strategies that contribute to effective learning and behavior change (Allen et al., 2002).

Dryland degradation results from complex interactions of multiple drivers, and affects a plurality of social and ecological processes and functions, often in complex, non-linear ways (Geist and Lambin, 2004; Gisladottir and Stocking, 2005; Reynolds et al., 2007), accompanied by multiple and often conflicting values, perspectives, attitudes and underlying sources of knowledge (Berkes et al., 2006). The multi-faceted nature of dryland response to

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environmental and human pressures call for integrated, transdisciplinary assessment approaches that consider the variety and trade-offs of land management impacts. However, regardless the assessment approach followed, the effective use of the results tends to be limited largely because local perspectives, interests, needs, and knowledge, are inadequately considered (Estrella and Gaventa, 1998; Hisschemller et al., 2001; Whitfield and Reed, 2012). Despite the many open questions on the benefits and risks of participatory approaches (e.g., Coglianese, 1997; Irvin and Stansbury, 2004; Webler and Tuler, 2001), it is acknowledged that the involvement of stakeholders in the assessment process contributes to ensuring the relevance and acceptance of the assessment approach and outcomes; enriching the assessment with local and contextual knowledge; and understanding and adequately considering the influence of the governance and cultural elements on the system assessed (Stirling, 2006; Salter et al., 2010).

Participatory processes are increasingly demanded by environmental agencies, organizations, and international bodies such as the United Nations Convention to Combat Desertification (UNCCD), and are more commonly incorporated to environmental legislation, assessment, planning, and decision-making (e.g., WFD, 2000; UNCCD, 2009). Frameworks have been developed to evaluate public participation processes (e.g., Rowe and Frewer, 2000), participatory integrated assessment (e.g., Salter et al., 2010), and the application of participatory research processes (e.g., Blackstock et al., 2007), which provide insight into the essential elements of a participatory environmental assessment. Accordingly, a variety of participatory methods and tools have been developed over the last decades (see for example van Asselt and Rijkens-Klomp, 2002) and have been increasingly incorporated into decision-making and integrated assessment in land and water management programs (e.g., Mostert, 2003; Salter et al., 2010). However, stakeholder participation in the evaluation of dryland restoration and sustainable dryland management is very scarce (Bautista et al., 2010; Schwilch et al., 2011), and participatory methods that effectively translate the evaluation of previous and ongoing management and restoration actions into new learning and enhanced capacity to responding to land degradation have received limited attention (Rojo et al., 2012; Schwilch et al., 2009, 2011; Derak and Cortina, 2014; Kong et al., 2014).

Participatory processes in land management contexts are assumed to contribute to efficiency and empowerment. However, those outcomes can rarely be ensured, as they depend on successfully addressing numerous critical issues, including stakeholder engagement, adequate stakeholder representation and ownership of the process, understanding of the attitudes and values of stakeholders, and recognizing and reconciling conflicts (Reed, 2008; Reed et al., 2013; Madden and McQuinn, 2014; De Vente et al., 2016; Wallace et al., 2016). For example, while stakeholder engagement and empowerment are often cited attributes of participatory processes, there is little evidence of the effectiveness of participation regarding empowerment, little acknowledgement of the many barriers to effective engagement, and very rare evaluation of engagement protocols (Carter, 2010; Cleaver, 1999). Similarly, while the main expected outcome from participation is mutual learning, which in turn is expected to lead to better informed decisions and better acceptance of decisions (von Korff et al., 2012), the learning-approach that underpins the participatory process is often poorly conceptualized, and the efficacy of participatory protocols with respect to learning is rarely evaluated (Huitema et al., 2010; Newig and Fritsch, 2009; Rowe and Frewer, 2000). There is therefore a need for participatory protocols that clearly define the pathway that leads to effective stakeholder engagement and mutual learning, and provide the mechanisms that allow the evaluation of the participatory process and outcomes.

We responded to this need by developing a participatory assessment approach, the PRACTICE Participatory and Integrated Assessment Protocol (hereafter the PRACTICE Protocol), that aims to: (a) integrate learning as a structural part of the assessment approach, incorporating individual and collective learning opportunities in a way that can be measured and tracked, (b) involve and engage a comprehensive representation of the relevant stakeholders from the start and throughout the assessment process, not only in the co-production of knowledge, but also in the design of the assessment method itself, and (c) provide theoretical support and guidelines for a complete participatory assessment process, from stakeholder identification to the assessment of the process itself, applicable to stakeholder participation in drylands worldwide, that can be easily tailored to particular target socio-ecological systems and context conditions, assessment scales, and alternatives to be evaluated. We expect individual and social learning to be emergent properties of the process that ultimately contribute to individual and/or concerted adoption of good practices and to strengthen resilience through capacity development of individuals and communities.

In the following section, we present the core elements that define the assessment approach proposed here, particularly with regard to stakeholder involvement, individual and social learning, and the selection of assessment criteria. Next, Section 3 presents the details of the PRACTICE protocol. Section 4 illustrates the potential of this methodology through its application to the assessment of land uses and management approaches in a Mediterranean fire-prone area in eastern Spain. Finally, in Sections 5 And 6, we review the achievements and limitations of the method proposed, identify directions for future research, and implementation.

2. The participatory assessment approach

2.1. Stakeholder participation

The degree of involvement of stakeholders in a participatory assessment process may range from a mere consultative role as information providers to full partnership and control of the process as co-designers and decision-makers, which implies increasing interactive participation, collaboration, and stakeholder empowerment (Arnstein, 1969; Biggs, 1989; Pretty, 1995; Davidson, 1998; Lawrence, 2006). The degree of involvement could also vary among stakeholders (Luyet et al., 2012). Several authors have proposed strategies to attribute the appropriate degree of involvement for the specific process and/or for each identified stakeholder or stakeholder group (Daniels et al., 1996; Vroom, 2003). Participatory approaches that pursue effective stakeholder engagement and empowerment should maximize the degree of stakeholder control over the process (Arnstein, 1969; Davidson, 1998). Advancing from existing frameworks, our approach facilitates full and equal involvement to all interested stakeholders from the inception of design to the final interpretation and communication of the outcomes. Thus, the stakeholders that participate in the assessment not only co-produce knowledge, they also co-design the assessment method itself by defining and prioritizing the criteria and indicators to be used, are the main actors involved in the analysis of the data gathered, and co-generate the assessment outcome. The key assumption underlying the goal of a wide involvement of all relevant individual stakeholders, groups and organizations is that the probability of adoption of improved management practices is likely to be higher when all stakeholder interests have contributed to design and conduct the assessment of the management alternatives (Beierle and Konisky, 2000; Young et al., 2013).

The PRACTICE protocol relies on a transparent partnership

between stakeholders and the scientific community. Scientists contribute to the participatory platform representing one of the various types of stakeholders. In this role, they propose criteria and perspectives on the alternatives assessed in the same way as the rest of the participants involved in the process. However, the most specific contribution of scientists to the assessment partnership is data gathering and processing. The group of participant scientists would collect and provide assessment data as needed for the criteria identified by the participatory stakeholder platform as a whole. This group would also assist the assessment process by processing and integrating assessment data and stakeholder perspectives by means of Multicriteria Decision Aid (MCDA) tools. The collaboration between scientists and other stakeholders provides the means for continuous updating of assessment data and capacity building, and can be an effective step toward collaborative adaptive management. It is conceived as a way of putting science at the service of a participatory decision-making process (Serrat-Capdevilla et al., 2009), for which stakeholders control the decisions.

2.2. An assessment process that targets learning

The participation of stakeholders in land management planning or assessment, even when it implies a high degree of stakeholder involvement, does not guarantee learning. People resist change in their world views, unless they are effectively challenged by new information and alternative perspectives (Allen et al., 2001; Reed and Page, 2016). Our approach is underpinned by a constructivist perspective (Kelly, 1955; Winter and Reed, 2016), which views learning as a knowledge reconstruction process rather than a knowledge transmission process. According to this perspective, individuals are active experimenters that formulate hypotheses about their world, test them, and if necessary revise them. However, pre-existing knowledge and beliefs are rather resilient and shape the interpretation of new information. Elicitation and assessment of these pre-existing world views, which aim to explicitly articulate existing explicit and implicit knowledge (Fazey et al., 2006), help the reconstruction – i.e. learning– process (Walker and Winter 2007).

In agreement with these ideas, the PRACTICE protocol follows a pattern of eliciting, confronting, and self-reviewing stakeholder perspectives that aims to facilitate learning. Baseline stakeholder perspectives are confronted with both assessment data and the perspectives of other stakeholders, and this is done through interactions and dialogue in a favorable environment for individual and social learning, as well as for reflections on the learning process itself (Finger and Verlaan, 1995; Keen et al., 2005; Reed et al., 2010). However, such a participatory environment may still fail to result in relevant changes in either individual or collective understanding and attitudes. Responding to the increasing demand to evaluate the outcomes and potential benefits of participatory approaches (Von Korff et al., 2012), the PRACTICE protocol incorporates self-evaluation mechanisms that operate at different steps of the process. Of particular interest is the comparison between the stakeholders' perspectives at the beginning and the end of each assessment cycle, which serves both to test the effectiveness of the learning approach and to reinforce transparency and the perceived value of knowledge exchange and collaborative learning.

2.3. Assessment criteria and indicators

Land condition results from coupled human–environmental processes; assessing land management should therefore consider biophysical as well as socioeconomic and cultural criteria that relate to ecosystem services and to human well-being (UNCCD, 2009; Schwilch et al., 2011; Sommer et al., 2011). Furthermore, sustainable management goals are based on social values, which can be effectively captured and used via participatory approaches (Winslow et al., 2011). Therefore, both local and scientific knowledge are essential to dryland assessment. We propose integrating site-specific assessment criteria, proposed by local stakeholders and likely tailored to the particular goals and socio-environmental context of the target management system, with science-based indicators of dryland ecosystem services that are consistently considered to be of critical importance by the United Nations Convention to Combat Desertification (UNCCD), the Convention on Biological Biodiversity (CBD), and the United Nations Framework Convention on Climate Change (UNFCCC). Based on the progress made in our scientific understanding of human-environmental dynamics in drylands (Low, 2013; Poulsen, 2013), we propose including biodiversity, which positively relates to dryland functioning and the provision of ecosystem services (MA, 2005); water and soil conservation, probably the most essential functions in drylands (Whitford, 2002); and carbon sequestration, of unquestionable global importance, as common criteria to be considered in the assessment of every dryland management practice. In the framework of the participatory process, the local stakeholders and experts will take into account the local context to propose the most suitable indicators for these criteria. Other potential criteria to be considered that relate to provisioning services and to socioeconomic and cultural aspects, which vary greatly between sites and regions, are generally best addressed by site-specific criteria proposed by local stakeholders. Framing the selection of indicators by the ecosystem services concept provides a common currency that facilitates global, across-site, and context analyses of the participatory process and the assessment outcomes (e.g., Sommer et al., 2011; Papanastasis et al., 2015; Schleyer et al., 2015; Maesa et al., 2016).

3. The method

The PRACTICE protocol integrates a number of participatory methods into a learning pathway (Fig. 1). Identification and engagement of stakeholders (Step 1) is followed by the elicitation at the individual level (prior to interaction and discussion) of the baseline views of stakeholders on both the management strategies and practices to be assessed and the criteria that should be considered in the assessment (Step 2). Step 3 focuses on prioritizing the assessment criteria in the framework of a focus group meeting. It provides the opportunity for stakeholders to review and discuss with each other the criteria and indicators selected and define their relative importance through both an individual and a collective weighting exercise. This exercise contributes to identify trade-offs between ecosystem services as well as to measure the level of agreement amongst stakeholders concerning their socio-ecological priorities. By selecting and prioritizing the criteria and indicators to be considered in the assessment process, the stakeholders become co-designers of the assessment method. Steps 4 and 5 represent scientific and technical work to be performed by the local experts and scientists regarding data collection and integration. Step 6 aims to produce a collective integrated evaluation (across the entire multi-stakeholder platform) of the management alternatives.

While this process results in an assessment product, the most relevant expected outcome is the knowledge integration and learning process. Step 6 provides the opportunity for stakeholders to self-review and discuss the evaluation of the target management alternatives after visualizing their impacts through the criteria they identified as important, backed by data collected on those criteria, and considering how the various alternatives outrank each other with the help of MCDA tools. Both Steps 3 and 6 allow for the

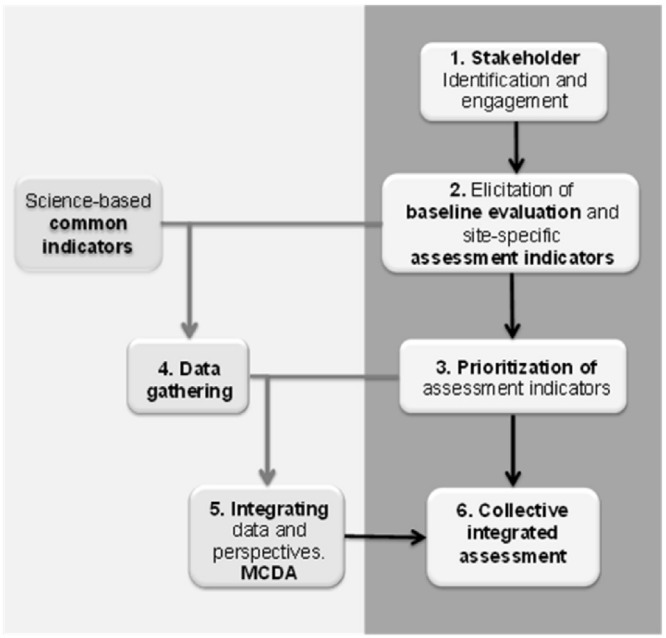

Fig. 1. Overview of the participatory integrated assessment process in PRACTICE Protocol. The main flow of participatory steps: Stakeholder identification and engagement, elicitation of baseline perspectives, prioritization of assessment criteria, and collective integrated evaluation (right side of the diagram) receives inputs from and provides inputs to expert-based activities: science-based indicators, data gathering, and Multicriteria Decision Analysis (left side of the diagram).

measurement of changes in stakeholder perspectives through quantitative comparisons of results combined with observations and associated qualitative content analysis of the interactions and discussion. There is an implicit cyclic nature in the process, in agreement with the continuous and cyclic nature of learning (Kolb, 1984), as final assessment must be viewed as a new baseline stakeholder perspective, both individual and collective, for any potential future iteration of the assessment process.

3.1. Stakeholder identification and engagement

Identification and engagement of stakeholders in any participatory process should ensure inclusivity and comprehensiveness, so that all interested and affected parties and the appropriate variety of viewpoints are considered (Richards et al., 2004). We propose using a chain-referral process (Bernard, 2006) to ensure a comprehensive mix of stakeholders with connections with the area and land management system of interest. The chain referral process allows stakeholders to influence who is included in the assessment multi-stakeholder platform, contributing to building partnership and reinforcing the role of the stakeholders as co-leaders and co-designers of the assessment process.

The proposed tool in the PRACTICE protocol for this step is a semi-structured interview (Denzin and Lincoln, 2011). This interview seeks to both elicit information on each participant's knowledge, perception, and experience on dryland management and engage the potential participant. In this regard, it is essential to share and agree with the stakeholders the basic principles and goals of the participatory process right from the outset (Reed, 2008). As part of an informed consent process, the interviewer will share with the potential participant a description of the risks and benefits associated to participation as well as any other relevant information requested that allows the stakeholder for deciding whether to participate or not. The interview will end with (chain-referral) question on other potential participants that the interviewed stakeholder would recommend recruiting.

3.2. Baseline individual stakeholder evaluation and indicator selection

Using a semi-structured interview with each stakeholder individually, this step of the participatory process deals with four main topics: (1) perception of the goals and socioenvironmental context of the management alternatives to be assessed, (2) stakeholder self-assessed knowledge on each land management alternative, (3) positive and negative effects of each alternative, and (4) recommendations for improvement of the alternatives assessed. Each participant stakeholder is also asked to rate each alternative on a 1-to-5 Likert scale, with 1 being a very bad choice and 5 being an excellent choice. This semi-quantitative assessment facilitates comparisons with the final participatory evaluation of the management alternatives. The semi-structured interviews for Step 1 and 2 can be performed as two parts of a single conversation, provided that the step order is properly followed.

From the conversation on positive and negative effects of each land management alternative, the interviewer elicits the implicit evaluation criteria and indicators considered by each stakeholder. For example, if a stakeholder mentioned “protection against erosion” as a positive effect of a given land management practice, “soil protection/conservation” would be listed by the interviewer as a potential criterion for that stakeholder. This preliminary list of criteria and indicators is then discussed with the interviewed stakeholder for final confirmation on the evaluation criteria and suitable indicators that he/she considers to be relevant.

Overall, the information elicited in this step 2 from each participant provides three critical elements to the assessment process. First, it provides the baseline, spontaneous assessment of the land management alternatives; this baseline assessment, once analyzed and integrated, will later be compared with the final individual and collective assessment, allowing the transparent tracking of the changes in perspectives produced along the process. Second, it provides a preliminary list of indicators (and implicit criteria) for the evaluation of the actions, which makes participant stakeholders more likely to take ownership of the process. Third, it contributes to making the pre-existing stakeholder perspectives explicit, which will aid in the learning process.

The assessment indicators elicited from each stakeholder through the semi-structured interviews, as well as the science-based general (common) indicators described above (see Section 2.3), are then pooled and integrated in a single consolidated list. The consolidated list will be then used in the prioritization of indicators (Step 3).

3.3. Defining the assessment criteria: participatory prioritization of indicators

The PRACTICE Protocol proposes developing this Step in the framework of a focus group meeting. The facilitator of the meeting first presents the consolidated list of indicators, providing a brief description of each indicator, based on the various descriptions given by the stakeholders during the previous (Step 2) interviews. Second, stakeholder priorities regarding the assessment indicators (and implicit criteria) are elicited through the “Pack of Cards” or revised Simos procedure (Figueira and Roy, 2002), a method designed to elicit weights for outranking Multicriteria decision analysis (MCDA) approaches. It is a simple method that facilitates the ranking of criteria in different levels and then indirectly determines the weights for those levels.

The indicator weighing is first done individually, so that the pre-

existing baseline prioritization of criteria is elicited. However, once the first weighting results are recoded, the facilitator of the meeting would promote group discussions on the general ranking and the relative distance between criteria. This enables the stakeholders to learn from each other and eventually reconsider their rankings, while also offering the opportunity for subsequent analysis of qualitative information on the stakeholders reasoning behind their prioritization decisions (Ocampo-Melgar and Orr, 2016). Differences between the initial and final rankings can be used as indirect metrics of the learning produced. The final post-discussion rankings and derived weights are then incorporated into a MCDA (Step 5) where they are applied to the data collected for each indicator and management alternative assessed.

3.4. Gathering science-based information

Step 4 addresses data gathering for the consolidated list of indicators that resulted from previous steps. Frequently it is possible and advisable to exploit already available data. However, additional sampling and measurements may be necessary for many of the indicators listed. Local researchers and experts within the assessment stakeholder platform would lead data gathering, being responsible for choosing the most appropriate metrics and survey methods. The participation of other stakeholders is however desirable and encouraged, as it would add the value of participatory monitoring and training to the overall co-production of knowledge process.

The PRACTICE protocol does not propose any particular socio-economic or biophysical assessment, method, as these should be tailored to the particular local conditions and constraints. However, as general recommendations, data gathering should focus on simple metrics and standard methods which could be easily adopted for future monitoring programs, and should meet the basic requirements of replicability and comparability. For example, a variety of indices that are based on vegetation cover and pattern metrics have proven to be useful as indicators for water (and soil) conservation potential in drylands (e.g., Tongway and Hindley, 2004; Mayor et al., 2008; Mayor and Bautista, 2012). Regarding carbon sequestration, the most frequently used indicators are soil organic carbon (SOC) and above-ground biomass. Both indicators have been included within the Essential Climate Variables list by the UNFCCC (GCOS, 2010). Land productivity could be effectively assessed in drylands using the ratio of Above-ground Net Primary Production (ANPP) to precipitation – the rain use efficiency (Le Houérou, 1984; Prince et al., 1998) as indicator. However, local stakeholders will likely propose site-specific indicators that relate to the productivity of the land and the provision of goods such as food, fiber, fuel wood, and timber. General data available on socio-economic and cultural indicators, even if available at fine administrative resolutions (e.g., municipality), may not capture the impacts of the specific land management alternatives assessed. However, this information can be refined to the management-practice level by including predetermined suitable questions on this topic either in the interviews and meetings conducted with the stakeholders in the first steps of the PRACTICE protocol or as part of a specific socio-economic/cultural survey conducted *ad hoc*.

3.5. Integrating scientific data and stakeholder perspectives

Step 5 in PRACTICE Protocol applies MCDA to integrating the stakeholder perspectives and prioritization on the assessment indicators (reflected as the weights elicited in Step 3) with the assessment data gathered in Step 4 for each of the selected indicators. The capacity of MCDA to integrate multiple partial preferences into a collective preference structure makes it a useful tool in participatory assessment (Favretto et al., 2016). There is an impressive number of operational approaches to MCDA, with their relative advantages and disadvantages largely depending on the characteristics of the problem addressed (Roy and Vanderpooten, 1996; Kangas and Kangas, 2005; Mendoza and Martins, 2006; Diaz-Balteiro and Romero, 2008; Ocampo-Melgar et al., 2016a,b). We propose adopting an outranking approach to MCDA (Figueira et al., 2005). An outranking MCDA approach appears to be particularly suitable for achieving the learning goals pursued by the PRACTICE protocol, mostly because this approach assumes that there may be not only one best alternative, providing partial ordering of pairs of alternatives and provides a transparent and easy to communicate view of the criteria and associated performance behind the outranking, which adds heuristic value to the MCDA exercise. Several outranking approaches, including the most common ELECTRE (Roy, 1991) and PROMETHEE (Brans and Vincke, 1985) could be used in this step of the PRACTICE protocol, yet ELECTRE has proven to be particularly suitable (Ocampo-Melgar et al., 2017).

3.6. Final collective integrated assessment

Step 6 finalizes the participatory assessment process. In the framework of a participatory evaluation meeting, the facilitators and the coordinators of data gathering and analysis share with the rest of the stakeholder platform (1) an overview of the data and average indicator weights that resulted from previous Steps 3 and 4; (2) a description of how the outranking MCDA works; and (3) the MCDA outranking results. In addition to the MCDA outputs that resulted from using the average weights elicited for each indicator from the whole stakeholder platform, it is advisable to show some examples of MCDA outputs resulting from the actual individual weights of individual stakeholders. This way, the role played by the relative importance given to each assessment criteria by the variety of stakeholder can be easily demonstrated. The participants are then encouraged to deliberate on the outputs presented; a process that can be guided by few evaluation questions on the various steps followed and their results.

Finally, the participants are asked to re-evaluate the land management alternatives, responding to the same questions used in Step 2 for the elicitation of their baseline perspectives on the alternatives. A variety of analytical and visual tools can help easily integrate and visualize the collective assessment outcome resulting from all individual evaluations (Case, 1990). Critical reflection about the differences between the baseline and final evaluations made, either individual or collective, is expected to reinforce learning. The assessment product, enriched with the knowledge and perspectives of many, is of unquestionable value on its own and contributes to better informed decision-making. However, knowledge integration and learning, together with increased trust, ownership, and support for the assessment outcome are the most powerful potential outcomes of the participatory process (Stringer et al., 2006; Measham, 2009; Raymond et al., 2010).

4. Case study in eastern Spain: Ayora valley

The PRACTICE protocol was implemented in Ayora valley, eastern Spain, for the participatory assessment of alternative land uses in a fire-prone forest area. Ayora valley represents very well the rural socio-ecological systems, land-use history, and environmental pressures of Mediterranean mountainous landscapes. The study area (38°50′34″– 39°10′15″N; 2°38′40″– 2°55′10″W) includes seven municipalities, the largest ones being Ayora and Enguera. In 1979, the valley was affected by a large (~35,000 ha) and devastating wildfire. The climate is characterized as dry

Mediterranean, with long dry and warm periods in summer that result in a high fire risk. Mean annual precipitation is 480 mm and mean annual temperature is 14 °C. Elevations range between 500 and 1130 m.a.s.l. Soils are calcareous and stony, developed over a variety of calcareous bedrocks: limestones, marls, dolomites, calcareous sandstone, and conglomerates. One third of the area is covered by agricultural lands, the rest being covered by shrublands and forests. The area has been the target subject of a number of research studies, mostly related to fire impacts, post-fire management and restoration (e.g., Malak and Pausas, 2006; Röder et al., 2008; Valdecantos et al., 2009), which have provided useful information and datasets on a variety of environmental aspects of the site. This fact, together with the variety of land uses and land management systems that can be found in the area, as well as the variety of potentially conflicting stakeholders' interests, make Ayora valley particularly suitable for demonstrating the participatory assessment of land use and management alternatives as guided by the PRACTICE protocol.

4.1. Socio-environmental context, land management system and stakeholder platform

The socio-ecological system of Ayora valley dramatically changed due to the 1979 wildfire. Before the wildfire, most of the area was covered by productive *Pinus halepensis* and *Pinus pinaster* forests that supported a relevant part of the economic activity in the area (Baeza et al., 2007). After the fire, aimed to control post-fire soil erosion and degradation, reduce fire risk, and provide employment opportunities, the Spanish Ministry of Agriculture designed an ambitious fire-management and reforestation plan, implemented over a number of years by the National and Regional Forest Administrations, which contributed to the current mosaic of land uses in the area. Four of the most extensive land use/land management alternatives were selected for this study: (1) shrublands, developed on areas with poor tree regeneration after the wildfire fire, mostly exploited for honey production and forage; (2) high-density pine forests, developed from natural regeneration after the fire; (3) pine forests from reforestation activities carried out during the 1980's and 1990's on denuded and scrubland areas; and (4) thinned pine forests, resulting from thinning and selective clearing activities on high-density pine stands. Due to the large wildfire, together with ongoing general socio-economic changes, the dominant activity in the region, which was previously based on forest productivity, transitioned to alternative uses of natural resources, especially honey production and some other non-timber forest products such as forage and mushrooms, as well as to the wind power industry, and gradually to the tertiary sector, in particular to rural tourism.

During the spring and summer of 2012, using a chain-referral process, we recruited 32 stakeholders - most of them directly linked to land management activities in the area - that actively engaged in the participatory assessment process. This multi-stakeholder platform (MSP) represented eleven different categories, including forest land users such as hunters and shepherds (16%), fire and forest management agencies (16%), Regional Department of natural resources (12%), forest land owners (9%), environmental NGOs (9%), local industries, such as honey production and wind power (9%), and other minor categories.

4.2. Selection and prioritization of assessment criteria

A 60–90 min semi-structured interview with each stakeholder was conducted in order to elicit the initial individual evaluation of the target alternatives and a set of locally relevant criteria. Each stakeholder was asked to describe the positive or negative outcomes they perceived to be associated with each alternative. These outcomes formed the base for a preliminary list of criteria. For example, several stakeholders mentioned the positive impacts of some of the alternatives in local small industries and employment; from this comments, the criterion “economic wealth” was elicited. The individual lists of criteria elicited from each participant stakeholder were later integrated and consolidated across the entire stakeholder platform. The stakeholder prioritization (weighting) of the criteria selected was conducted in the framework of two focus group meetings, each of them involving approximately half of the Ayora MSP yet still representing the majority of the 11 stakeholder categories. The decision to conduct two meetings, each in a different town (Ayora or Enguera) was made in order to minimize geographical constraints to participation. Using the Revised Simos' procedure (Figueira and Roy, 2002), each participant stakeholder expressed his/her perspectives on the relative importance of each criteria. After a group discussion on the individual perspectives and overall results obtained, each stakeholder had the opportunity to revise the prioritization (ordering of indicator cards) made.

Overall, the Ayora MSP selected and valued 13 assessment criteria that represented a suite of socio-economic, cultural, and biophysical aspects (Fig. 2), including some (e.g., biodiversity, carbon sequestration) that had already been proposed by the international scientific community. As could be expected from the fire history of the target area, the stakeholders consistently valued fire risk as the most important assessment criterion, followed by soil and water conservation. While (family) economic wealth was highly valued, cost was the least valued criteria, probably reflecting the fact that the type of management activities involved in the alternatives assessed are mostly funded by public agencies. Aesthetic and recreational value also received relatively low weights, in agreement with the still very incipient development of the rural tourism industry. The initial prioritization made by each stakeholder varied little with the prioritization made after the group

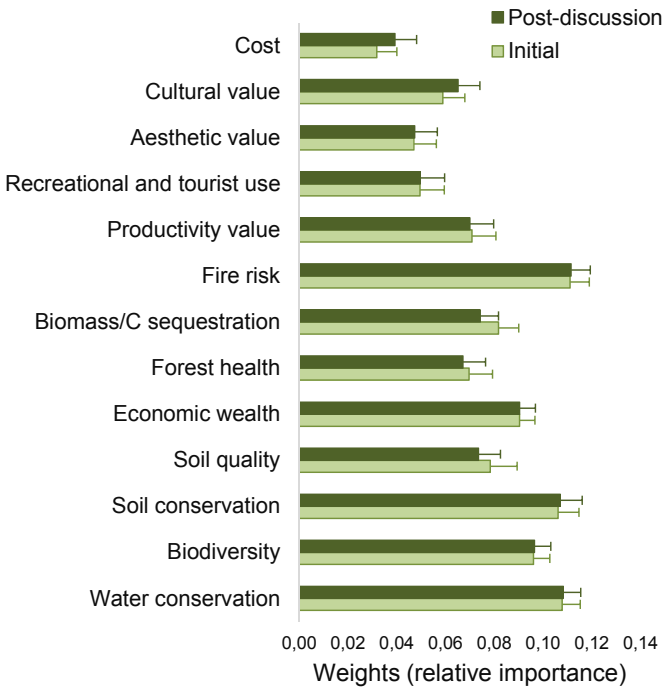

Fig. 2. Consolidated list of criteria selected and prioritized (weights) by the Ayora stakeholder platform. Weights are averaged values (+1 SE) from the weights provided by each individual stakeholder.

discussion on the weights, except for a slight increase in the importance given to cost and cultural value and a slight decrease in the importance of carbon sequestration. This outcome indicates that the focus group discussion on the assessment criteria only contributed to fine tuning the initial individual perspectives, but did not result in critical changes in the relative importance given to each of the indicators selected, which was very consistent among the participant stakeholders.

4.3. Integrated assessment and collective evaluation

The assessment criteria proposed by the Ayora MSP were translated into particular assessment indicators (Table S1; Supplementary material). The data needed on each indicator were gathered from a variety of sources, including direct field measurements of biophysical indicators (e.g., plant species richness, plant cover); field assessment of functional indices (LFA-indices for infiltration and nutrient cycling; Tongway and Hindley, 2004); expert judgments (e.g., on fuel models and fire risk); available records on management costs; and interview-based surveys on socio-economic and cultural aspects (e.g., on the aesthetic and cultural values of the alternatives). Both quantitative, either continuous or discrete, and qualitative (ratings) data were gathered (Table S1; Supplementary material).

Considering the data on each of the indicators selected, the average indicators' weights given by the multi-stakeholder platform, and the integration of these through the outranking MCDA method ELECTRE IS (Figueira et al., 2013), pine thinning outranked all of the other actions, followed by pine reforestation, while shrubland and dense pine forests were similarly outranked by the other two, without major differences between them (Fig. 3). Thinned pine forests performed equal or better than the other alternatives on all criteria except cost. Pine reforestations performed better than shrublands regarding soil and water conservation, as well as aesthetic, cultural and recreational values. However, pine reforestations and shrublands performed similar regarding the rest of criteria, including productivity value, economic wealth, soil quality, and biodiversity.

In December 2012, a final participatory evaluation meeting was held in the town of Ayora, involving all participating stakeholders in the Ayora MSP. The facilitators of the meeting (first and second co-authors of this work) sequentially shared with the stakeholders a summary of the data gathered, a description of the integration process through the MCDA, and a summary of the MCDA results. After the corresponding group discussions on the results and methods presented, the stakeholders were asked to re-evaluate the target land use alternatives and propose positive and negative aspects, as well as rate the alternatives on a Likert scale (1–5), following the same approach that the one used in the elicitation of the initial, baseline stakeholder perspectives (Step 2 in the PRACTICE protocol). With the aid of visual tools displayed on suitable boards prepared *ad-hoc*, the stakeholders presented and shared their re-evaluation results, which provided a general overview of the overall assessment made by the entire Ayora MSP and facilitated further discussion. In parallel, a group of collaborating research assistants analyzed the differences between the initial, baseline stakeholder ratings and the final ones resulting from the re-evaluation of the alternatives. The results from this comparison (Fig. 4) showed significant shifts between initial and final perspectives towards a decreasing appreciation for most alternatives (initially mostly rated as moderate-quality choices during the elicitation of initial perspectives, and then mostly rated as bad choices, during the final participatory evaluation), except for thinned pine forests, which were rated as excellent choice by almost 100% of the stakeholders. To some extent the results from the re-evaluation of alternatives reflected the MCDA results. For example, the good MCDA-ranking of thinned pine forests probably influenced the higher rating of this alternative in the final re-evaluation. However, some other changes between the initial and final ratings were not in agreement with the MCDA results and instead reflected the influence of particular consensus-building discussions during the evaluation meeting. These results highlight the complex network of influences that may contribute to relevant changes in perspectives and attitudes.

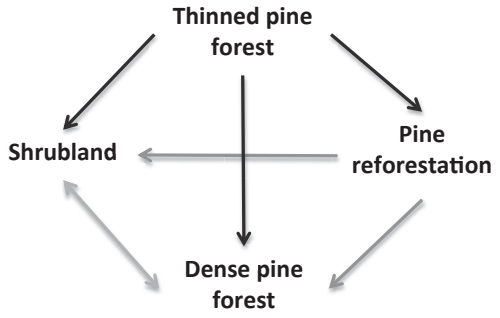

Fig. 3. Graph kernel of the outcome of ELECTRE IS MCDA on the four land use alternatives evaluated in Ayora. The arrows point towards the action that was outranked in each two-way comparison. A double-direction arrow indicates no relevant differences between the two alternatives compared.

The differences found between the initial individual stakeholder perspectives and the final re-evaluation of alternatives reinforced the learning value given to the participatory process by the stakeholders involved. A final discussion on the PRACTICE protocol approach yielded very positive comments from the participant stakeholders, who acknowledged and valued the collaborative work and the exchange and co-production of knowledge between scientists and non-scientists, as well as the potential of the approach for successfully addressing a large variety of environmental assessment and decision-making processes.

5. Discussion

The magnitude of existing and projected stresses on dryland systems calls for the adoption of sustainable management systems that help reverse current degradation trends and enhance preparedness for the future. Many traditional and current management practices and strategies are no longer suitable for this purpose (Boko et al., 2007; FAO, 2011). At the same time, a number of constraints, including a low capacity of existing knowledge transfer systems to support stakeholders in their decision making, limit the adoption of more sustainable management alternatives (van Kerkhoff and Lebel, 2006). In this paper, we propose a participatory assessment method, the PRACTICE protocol, that aims to translate the evaluation of previous and ongoing management actions into new learning and enhanced capacity to responding to land degradation.

Despite the increasing application of participatory approaches in many areas of environmental research and practice, it is often argued that there is little evidence of their expected benefits, particularly regarding social learning, adoption, and empowerment (Cleaver, 1999; Rowe and Frewer, 2000; Newig and Fritsch, 2009). This criticism points to the need for incorporating evaluation mechanisms in the participatory protocols (Armah et al., 2009; Von Korff et al., 2012). Our participatory assessment approach specifically addresses this need by establishing self-evaluation opportunities at different steps of the process. Thus, the PRACTICE protocol

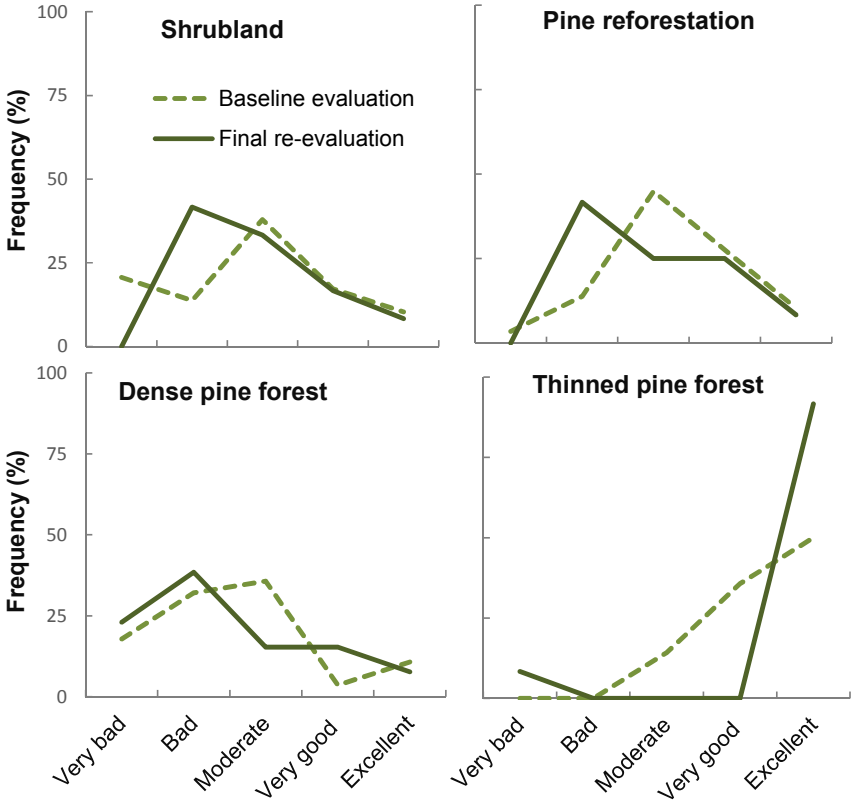

Fig. 4. Frequency distribution (%) of the initial baseline (light green) and final (dark green) ratings (from very bad to excellent) given to each land use alternative by the Ayora stakeholder platform. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

allows measuring and tracking changes in stakeholders' views with respect to the target alternatives under evaluation, and to their decisions about selection and prioritization of assessment criteria before and after interactions with other stakeholders. The protocol also provides the means for those stakeholders to see the effect of their decisions relative to actual data collected for each criterion. Each stakeholder therefore has multiple inter-related opportunities to learn, not only from other stakeholders, but also from systematic feedback on the influence of their own decisions on the final outranking of alternatives under evaluation. The process is transparent in both the way it incorporates the diversity of knowledge and values and the way it integrates data and stakeholder perspectives.

In participatory processes, special attention has to be paid to the adequacy and representativeness of the stakeholders involved, avoiding biases in the identification and selection of the participants (Luyet et al., 2012; Newig and Fritsch, 2009; Stanghellini, 2010). The PRACTICE protocol relies on the combination of analytical (top-down, primed by pre-identified stakeholders) and reconstructive (bottom-up, identified through the referral process) stakeholder identification methods, which can be efficient with respect to time and resources needed, but also effective in the identification of traditionally marginalized or peripheral stakeholder groups (Reed et al., 2009). However, bias is still possible and there is risk of reproducing existing homogeneous networks. By using a multiple entry point to the chain referral process, this bias can largely be avoided (Luyet et al., 2012).

Overall, the approach presented here qualifies for being a collaborative and transformative type of participation (Lawrence, 2006), in which participants control the process and share decisions. It also meets most of the essential principles for successful participation identified in the literature, including the integration of local and scientific knowledge; an early involvement of stakeholders; and a transparent process that promotes learning and trust among stakeholders (Reed, 2008; Luyet et al., 2012). This approach has been successfully used in contrasting land management systems such as public forest lands in the Mediterranean Europe (the current study), semiarid rangelands under federal management in southwestern USA (Ocampo-Melgar and Orr, 2016), and livestock farming in the South African Kalahari (Kong et al., 2014), among other systems (Rojo et al., 2012). It must be stressed however that the proposed protocol shares with existing participatory frameworks a variety of potential risks, including the potential for resulting in a costly and time consuming process, generating stakeholder frustration, identifying and bringing new conflicts to the surface, involving stakeholders that are not relevant to the issue addressed, ignoring individual and relative levels of power within the group of participating stakeholders, etc. (Armah et al., 2009; Luyet et al., 2012; Mitchell et al., 1997), which can largely influence the outcomes of a participatory process (De Vente et al., 2016; Reed et al., 2009; Rowe and Frewer, 2005). Furthermore, land management decision-making is influenced by many situational factors such as financial resources, land tenure, and social norms, so that high level of knowledge and positive attitude alone did not always result in behavior change (Kong et al., 2014; Leeuwis, 2000). Although a transparent learning-centered participatory approach can help to reveal and deal with some of these factors, there is a need for more interdisciplinary research to understand the multiscale network of influences that drive stakeholder management decisions. In addition, using this type of approach to evaluate alternatives under a variety of future scenarios can enhance adaptive capacity and help build resilience in the management system

(Whitfield and Reed, 2012).

6. Conclusions and final remarks

Based on the assumption that site-specific behavioral changes in land management are more likely by engaging the relevant stakeholders in the assessment of alternatives, and by doing so in ways that facilitate effective knowledge exchange and learning, we propose a participatory assessment method that systematically incorporates individual and collective learning opportunities, as well as the means to track and evaluate the changes in stakeholder's perspectives that may result from the participatory process. The strongest points of our approach are the transparent learning-centered nature of the process, the co-production of knowledge facilitated by democratic rather than technocratic interaction between scientists and stakeholders, and the involvement of stakeholders as both co-designers of the assessment method and evaluators of the management practices. However, as it is the case for all participatory processes, the realization of the expected benefits of this participatory assessment approach will eventually depend on the competent fine-tuning and implementation of the various critical steps in the process and the appropriate consideration of the political and social contexts.

The participatory assessment method presented here may be initiated by local scientists, experts, NGOs, or governmental agencies, which may also act as facilitators. A significant aspect of the approach is the idea of partnership between scientists and stakeholders. Both groups interact in a complementary way, contributing with their respective strengths to the assessment process. However, the process is entirely stakeholder-centered: the stakeholders are the actual evaluators of the target management actions and strategies and the decision-makers regarding their implementation. Although the PRACTICE approach is tailored to the assessment of dryland management, it may be adapted to a wide range of socio-ecological systems and governance scales. The specific multi-stakeholder platform and the target alternatives to be assessed would define the implementation scale of the approach.

The approach proposed is valuable as a means to generate and exchange knowledge that ultimately contributes to improve decision making, yet it is most valuable as an end itself, as a process that promotes learning and trust among stakeholders, facilitating the integration of scientific and local knowledge. This is the most powerful outcome. Quoting a participant stakeholder from Ayora case study “Conversely to common ways of decision-making in forest management, this method facilitates equal participation to all concerned actors, a good model to apply in a variety of decision-making processes.”

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jenvman.2016.11.050.

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