



Participatory multi-criteria decision aid: Operationalizing an integrated assessment of ecosystem services



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ABSTRACT

Ongoing ecosystem alterations underscore the need for ecosystem service assessment to urgently enter policy-making. Participatory methods and a systematic inclusion of stakeholders are crucial yet underdeveloped cornerstones of environmental decision making. This study aims at conducting a transparent and legitimized *integrated assessment of ecosystem services* that rigorously involves stakeholder knowledge and values in environmental decision making. To this end, *participatory multi-criteria decision aid* was applied to the case of declining vineyard ecosystems surrounding the National Park of Doñana in south-west Spain. Data was gained by means of a survey ($n = 178$), interviews ($n = 21$), and three stakeholder workshops (each with 15–21 participants). We found that stakeholder engagement improved all steps of decision making, including problem structuring, policy evaluation, and operationalization. Our results thereby reinforce two major arguments for adopting participatory methods in integrated ecosystem service assessments: (1) the inclusion of stakeholders and their objectives adds legitimacy to decision making; (2) the integration of stakeholder knowledge provides important information for decision making.

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1. Introduction

Environmental policy-making and practice increasingly embraces the ecosystem services (ES) approach (Posner et al., 2016; Costanza et al., 2017; Dick et al., 2017; Saarikoski et al., 2017). Multi-criteria decision aid (MCDA) has been promoted as a methodological framework to include stakeholders in order to mitigate some of the major challenges for an integrated assessment of ES (IAES) (Uhde et al., 2015; Langemeyer et al., 2016; Saarikoski et al., 2016; Turner et al., 2016; Barton and Harrison, 2017; Dunford et al., 2017). Major challenges include: (1) evaluating policies considering and integrating ecological, social, and economic objectives (i.e., multiple values); (2) trading-off the multiple benefits social-ecological systems sustain for different people; and

(3) informing environmental decision making to secure a resilient supply of ES (cf. Jacobs et al., 2016).

The number of ES assessments across the world has increased rapidly over recent years, contributing to an improved understanding of the many ways in which human well-being depends on healthy ecosystems (e.g., Braat, 2014; Haase et al., 2014). However, decision making, especially at a local level, still largely lacks detailed information on the social-ecological linkages that sustain ES flows (Guerry et al., 2015). Further, operational IAES approaches that serve decision making still remain poorly developed (Gómez-Baggethun et al., 2016). Gradual “fine-tuning”, mapping, and modeling is one way to improve ES assessments for local decision making; yet, drawing on Funtowicz and Ravetz (1994) and Fish et al. (2016), it seems pertinent to additionally broaden decision making by integrating local stakeholder knowledge and objectives, especially if stakes are high for those affected by the decision (Fish et al., 2016). Barton and Harrison (2017) recommend an IAES to integrate multiple methods and diverse values, to be place-based, purpose-oriented and participatory. This is expected to enhance the transparency of an IAES, such as in the way it deals with

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uncertainty (Ruckelshaus et al., 2015). Jacobs et al. (2016) highlighted the negotiation of conflicting societal needs and objectives as a key challenge for integrating ES values (i.e., diverse stakeholder preferences) into environmental decision making. Conflicting objectives underlying such decisions require considerations of ethical-normative arguments related to equity, social inclusion, intra- and inter-generational justice, and intrinsic values of nature (Wittmer et al., 2006).

MCDA can be described as a step-wise approach to structure and inform decision making (Saarikoski et al., 2016). Thus far, step-wise MCDA approaches for IAES commonly include: (i) definition of policy alternatives, (ii) definition of evaluation criteria, (iii) criteria scoring, (iv) criteria weighting, and (v) the application of an aggregation model (i.e., calculating a uniform quantitative index for comparing the policy alternatives) (Langemeyer et al., 2016). MCDA should have a strong theoretical capacity to accommodate stakeholder knowledge and conflicting objectives. Nevertheless, the inclusion of stakeholders in MCDA has generally been limited to single steps (Allain et al., 2017). The first two steps, which we summarize in this study as *problem structuring*, generally receive the least importance in MCDA from a participatory perspective (Langemeyer et al., 2016; Allain et al., 2017). A rare example for a participatory definition of policy alternatives is given by Fürst et al. (2013), who use stakeholder working groups in the development of landscape planning scenarios for Eastern Germany. Similarly, only a few studies (e.g., Bryan and Kandulu, 2011) rely on participatory approaches for the definition of evaluation criteria; in IAES this means the selection of ES is to be considered in an assessment. Usually, the evaluation criteria are introduced by researchers (Allain et al., 2017). Participatory approaches are more commonly used at the criteria performance scoring step, although often limited to a narrow circle of experts. A noteworthy example for using a wider participatory process for criteria performance scoring has been provided by Koschke et al. (2012). By revealing (expert and non-expert) stakeholder knowledge the authors determined the performance of less tangible ES (aesthetics, recreation, and ecotourism) under different policy alternatives and thereby manage to adjust for data-shortages on these ES. The most common step for stakeholder inclusion is the elicitation of criteria weights (Langemeyer et al., 2016). Objectives related to the supply of specific ES are thereby operationalized as criteria weights based on individual survey-based valuation or deliberative group valuation approaches (e.g., Karjalainen et al., 2013; Srdjevic et al., 2013; Zhang and Lu, 2010; Zia et al., 2011).

Only exceptionally has a more rigorous inclusion of stakeholders at multiple steps been carried out (e.g., Cork and Proctor, 2005). This suggests participation has not yet become an integrated part of decision-making processes supported by MCDA. A rigorous integration of stakeholder knowledge and objectives into environmental decision making as demanded by Fish et al. (2016) requires participatory approaches that stretch out across all common steps of MCDA. In addition, we follow Saarikoski et al. (2016) in the assumption that MCDA becomes most valuable when it serves to open up discussion. From this perspective, the application of an aggregation model is not the end-point of the assessment but the starting point for promoting reflection among stakeholders. Such an inclusive process can be referred to as *participatory MCDA* and it is intended to provide a clear structure for decision making that is comprehensible for stakeholders and facilitates utmost transparency (Wittmer et al., 2006). Participatory MCDA builds upon O'Neill's (2001) basic principle that effective and legitimate conflict resolution procedures in fuzzy environments require a high degree of transparency and stakeholder involvement, even more so if stakeholders are strongly affected by a decision (cf. Funtowicz and Ravetz, 1994; Fish et al., 2016). The legitimacy of participatory MCDA thus relies on the representation and engagement of stake-

holders at all steps of the decision making process. This makes participatory MCDA different from other MCDA approaches where complex mathematical evaluation models often diminish the transparency and comprehensiveness for non-expert stakeholders.

The goal of this study was to apply an IAES that rigorously integrates place-based stakeholder knowledge and objectives within a *participatory MCDA* to enhance the transparency and legitimacy of the decision-making process it intends to inform. As a case study, we addressed traditional vineyards in the surroundings of the National Park of Doñana in south-west Spain, where land-use change is driving the decline of this agroecosystem and the ES it provides (Gómez-Baggethun et al., 2011; Martín-López et al., 2011). Land-use change has been described as a main driver for the loss of ES from cultural landscapes (Foley et al., 2005; Lambin and Meyfroidt, 2010), with cultural landscapes adjacent to protected areas being especially affected due to spill-over effects from conservation policies (Radeloff et al., 2010; Gimmi et al., 2011). Data was collected between 2014 and 2017. An initial survey was conducted among 178 local residents in 2014, followed by two subsequent rounds of interviews with 10 and 11 stakeholders in 2014 and 2016, respectively, in conjunction with three stakeholder workshops in 2015, 2016, and 2017. The specific objectives of our study were (a) to assess ES provided by traditional vineyards as perceived by locals and to define policy alternatives that promote ES stewardship; (b) to evaluate alternative policies under consideration of multiple stakeholder objectives; and (c) to critically assess the use of participatory MCDA for IAES.

2. Case study

The *National Park of Doñana*, created in 1969 and located at the mouth of the river Guadalquivir, can be considered one of the most emblematic wetlands in Europe and is internationally known for its outstanding biodiversity and related ecological and cultural values (Fernández-Delgado, 2005). In response to an increasing degradation and agricultural intensification in the areas surrounding the National Park, a 540 km² “transition zone” was created in 1989 to delimit those areas that are socially and economically tied to the Park (Fig. 1). Grapevine has been the dominant crop in the transition zone (Zaller et al., 2015) and the century-long tradition of wine farming is highly adapted to Doñana's sensitive ecosystems. In addition to grape (8.3 tons per hectare), vinegar (12.1 hl/ha) and wine (48.73 hl/ha/year), traditional vineyards sustain diverse regulating ES, such as erosion control (Gaitán-Cremaschi et al., 2017), and cultural ES, such as local identity, social cohesion and traditional ecological knowledge (Gómez-Baggethun et al., 2012). Wine farmers are thus important stewards who sustain these ES. Most of these farmers are smallholders and cultivate an average 1.5 ha of land, with wine production constituting a supplementary income only. Vineyards are mainly located in the municipalities of *Bollullos Par del Condado* (39%), *Rociana del Condado* (16%), and *Almonte* (12%), with the remaining 33% distributed across another 15 municipalities.

2.1. Problem definition

The overarching challenge in our case study is the development, evaluation, and consolidation of policies to maintain Doñana's traditional vineyards and the ES that they provide. Between 1983 and today, the area of wine production in Doñana decreased from about 147 km² to about 54 km². In parallel, production declined from an average 90.000 tons/year in the 1980 s to about 46.000 tons/year in the 1990 s. A direct consequence was a reduction of employment in the sector and the loss of cultural identity and cultural heritage in a region where many local festivals and cele-

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