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How Do Multi-criteria Assessments Address Landscape-level Problems? A Review of Studies and Practices

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ABSTRACT

Viewing the landscape as a spatialized social-ecological system allows identification of specific management challenges: integration of multiple views, multiple levels of organization, complex spatial-temporal patterns and uncertainties. Multi-criteria assessments (MCAs), which allow the comparison of alternative actions when multiple interests collide, are considered adequate to support landscape management. However, there is no consensus about how they should be applied and can integrate both multiple views and spatial dimension. We conducted an extensive quantitative and qualitative literature review targeting MCAs with a participatory and spatial approach. Our results suggest that (1) for sustainability assessments, participatory and spatial approaches endorse different rationales and hybrid methods are not so common; (2) within those methods, only scenario-selection methods (as opposed to design methods) can integrate spatially-explicit, spatially-implicit, place-specific, and overall values; and (3) current applications, which aggregate values ignoring their spatial and social distribution, do not coincide with the nature of landscape-management challenges. In addition, they give little importance to the structuration of information and to collective deliberation. We conclude that, in the absence of a good match between spatiality and participation, MCAs should, for now, be handled as insightful but distorted tools to explore and structure landscape-level management problems.

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1. Introduction

Landscapes are complex social-ecological systems (SES) because many human and natural processes mutually interact (Bastian, 2001; Cumming et al., 2012; Naveh, 2000; Wu, 2006) and because they are shaped by a social history (Antrop, 2000; Pedroli et al., 2006), which promotes perceptions, values or expectations that differ spatially and among individuals. This makes it challenging to collectively define a desirable future for a given landscape. Many possible ways exist to address this issue; one of them is multi-criteria assessment (MCA). Nonetheless, there is no consensus on how to apply this method given the nature of landscape-level challenges.

A first challenge comes from the complexity of processes and multiple interactions. Because landscapes are characterized by interdependencies between human societies and their environment that originate from a co-evolutionary history (Berkes et al., 2000; Costanza et al., 1998; Daily, 1997; Kallis and Norgaard, 2010), they exhibit non-linear and cascading effects that make their trajectories of change impossible to predict (Kinzig et al., 2006; Walker et al., 2004). It is generally acknowledged that command-and-control approaches (Folke et al., 2002; Holling and Meffe, 1996) and risk assessment (Linkov et al., 2014) are ill-suited in this context. Instead, scholars advocate exploring possibilities for change (Berkes et al., 2002; Olsson et al., 2006) and adopting an adaptive management approach (Linkov et al., 2006; Plummer, 2009).

Another challenge with landscape-level problems arises because the different groups concerned hold different and sometimes irreconcilable values (Gómez-Sal et al., 2003; Hunziker et al., 2008; Swedeen, 2006). This problem of multiple views, which is common to many decision-making situations, has led to recommendations to include non-experts in evaluations of the quality of decisions (Funtowicz and Ravetz, 1990) and explicitly consider incommensurabilities[1] (Martinez-Alier et al., 1998; Munda, 2004). Deliberative approaches and MCAs involving multiple stakeholders are considered particularly well-suited to operationalize these principles (Frame and Brown, 2008; Munda, 2004).

The landscape is a complex system that has another challenging characteristic: material resources and populations are distributed in space. Human and natural systems can interact "through" the spatial dimension: social and ecological processes increasingly overlap as perspective widens to a global scale (Alessa et al., 2008), and spatial mismatches can have far-reaching consequences (Cumming et al., 2012; Wilson et al., 1999). Likewise, human and natural systems can interact "within" the spatial dimension: processes such as species migration, farming dynamics or social exclusion are closely related to spatial patterns, such as habitat heterogeneity and the spatial distribution of crops or infrastructure networks (Benoît et al., 2012; Cumming, 2011). Accounting for complexity at the landscape level therefore requires considering these different spatial interactions. This is one reason why geographic information systems (GIS), given the wide possibilities they offer to investigate spatial relationships, have become key tools to analyze and resolve landscape-level management problems (Malczewski, 2006; Malczewski and Rinner, 2015).

Because social-ecological interactions have a spatial dimension, diverse and potentially conflicting representations of space, i.e. new types of incommensurabilities, coexist within a landscape. Because people relate to places in many different ways – not only through their actions, but also through their perceptions and history (Antrop, 2005) – they do not have the same definition of boundaries, meaningful zoning, significant places, features of identity, etc. The same occurs with expert descriptions: relevant extents, resolutions and locations differ when describing water dynamics or pollination. The ecological economics community does not formally address these types of incommensurabilities specific to spatial problems, though it is aware of "scale biases" when stakeholders express value judgments (Hein et al., 2006; McFadden, 1994; Zia et al., 2011). Incommensurabilities are not well integrated into spatial decision support systems either, because the latter are designed as "expert systems" that rely on a uniform understanding of space (Ramsey, 2009).

Applying MCAs to landscape management problems raises the fundamental challenge of integrating spatiality with multiple views. In an initial step to meet this challenge, we investigate current practices of MCA reported in the scientific literature that combine a spatial approach with multi-stakeholder or participatory approaches. More specifically, we address the following issues: how, and how well, MCA practices reflect landscape-specific challenges.

These issues are addressed following three nested analyses that enable us to:

(i) Position spatial and participatory approaches within the broad scope of multi-criteria methods
(ii) Distinguish types of MCA methods that combine spatial and participatory approaches
(iii) Clarify how MCAs are applied to assess landscape-management scenarios
(iv) Generate suggestions for using MCAs at the landscape level.

2. Materials and Methods

This literature review follows three steps (the overall method is described in Fig. 1). First, we performed a lexicometric analysis of a large sample of studies to characterize the position of sustainability assessments, participatory approaches and spatial approaches within the wide spectrum of multi-criteria methods (Section 2.2). Second, we qualitatively classified applications of multi-criteria approaches mixed with participatory and spatialization methods in the field of natural resource management (Section 2.3). Our aim was to provide a typology of existing methods with their general steps. Third, we focused on a specific type of methods arising from the typology, "scenario-selection support method", and undertook a detailed qualitative analysis of the corresponding case-studies (Section 2.4).

2.1. Bibliographical Data

We generated three datasets of studies of decreasing size using the Web of Science database, corresponding to the three steps of our review. For better traceability, we summarized this selection process in a PRISMA diagram[2] (Moher et al., 2009) (Fig. 1). A large dataset of abstracts (10,691) was selected to analyze recent trends (2005–2015) in

[1] Specific concepts are defined in Appendix A.

[2] The "PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement" includes a flow chart that maps out the number of records identified, selected for analysis and excluded. The general aim is to improve the reporting of systematic reviews and to help the reader identify bias in the selected materials.