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Multi-Criteria Decision Analysis and Cost-Benefit Analysis: Comparing alternative frameworks for integrated valuation of ecosystem services

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ABSTRACT

Multi-Criteria Decision Analysis (MCDA) methods has been promoted as an alternative approach to monetary economic valuation of ecosystem services in Cost-Benefit Analysis framework (CBA). We discuss the potential of MCDA in providing a framework for integrated valuation of ecosystem services. We conclude that MCDA does in general perform better than CBA and associated monetary valuation techniques in several aspects that are essential in ecosystem service valuation. These include the ability of a valuation method to account for multiple dimensions of well-being, including ecological and economic as well as cultural and moral aspects of a policy or management problem and to facilitate open and transparent public debate on the pros and cons of alternative courses of action, including the distribution of gains and losses across beneficiaries of ecosystem services. The capacity of MCDA to articulate values related to ecosystem services depends on individual methods used in the MCDA process. More importantly, it depends of the ways in which the process is organized and facilitated. However, MCDA cannot provide representative information of the values of wider population. Further empirical and theoretical research is needed on the potential of hybrid methodologies to combine monetary valuation and MCDA in fruitful ways.

1. Introduction

Ecosystem services such as pollination, flood control and carbon sequestration are vital for human well-being. The importance of these services is widely recognized, but operational mechanisms and approaches for integrating them into policy-making and management practices are still poorly developed (Kareiva et al., 2011; Guerry et al., 2015; Kabisch, 2015). In a wave of 'new environmental pragmatism' (Spash, 2001), monetary valuation has been promoted as the key strategy for including the value of ecosystems in decision-making. For example, the influential initiative The Economics of Ecosystems and Biodiversity (TEEB) maintains that the best way to mainstream the ecosystem service approach is to make the previously invisible changes in nature's flows into the economy visible through economic valuation, and communicate the value of ecosystems "in the language of the world's dominant economic and political model" (ten Brink, 2011, xxix). Monetary valuation of ecosystem services is also endorsed by the Natural Capital project (Kareiva et al., 2011), and assigning monetary value to ecosystem components and functions has become one of the most researched topics in ecosystem service literature (de Groot et al., 2012).

Yet monetary valuation of the environment is also criticized on the grounds that it can actually undermine environmental protection and pave the way for commodification of nature (Gómez-Baggethun and Ruiz-Pérez 2011). According to the critics, economic valuation fails to capture social and ethical concerns such as cultural and moral values because they are not amenable to tradeoffs and monetary transactions (Chan et al., 2012; Kenter et al. 2015). The critics also warn that

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monetary valuation can reduce citizen values, including normative beliefs, principles and collective meanings into consumer preferences (Sagoff, 1998; Spash, 2007; VatnVatn, 2009), and ignore ecological thresholds and distributional impacts (Wegner and Pascual, 2011; Farley, 2012; Kallis et al., 2013).

Given the limitations of monetary valuation of ecosystem services, there is a growing interest in mixed or multiple criteria assessment methods such as participatory Multi-Criteria Decision Analysis (MCDA), which has variably be seen as an alternative or complementary approach to monetary valuation of ecosystem services in Cost Benefit Analysis (CBA) framework (Vatn, 2009; de Groot et al., 2010; Spangenberg and Settele, 2010; Wegner and Pascual, 2011; Newton et al., 2012; Chan et al., 2012). MCDA is also expected to provide a compatible methodological framework for deliberative valuation, which is considered helpful in addressing plural value dimensions related to common goods such as ecosystem services (Vatn, 2009; Wegner and Pascual, 2011). According to Vatn (2009), MCDA is particularly suited for integrated valuation of ecosystem services because it can combine information about the performance of the alternatives with respect to evaluation criteria with subjective judgments about the relative importance of the criteria in a particular decision-making context.

MCDA is widely applied in the academic literature on environmental decision-making (Kiker et al., 2005; Huang et al., 2011; Keisler and Linkov, 2014), including biodiversity planning and management (Geneletti, 2007, 2008) and there is an emerging literature on the use of MCDA in ecosystem service assessment (for a review, see Langemeyer et al. (2016)). However, MCDA is also criticized for lack of representativeness and for not providing informing policy-makers about effectiveness in terms of resource use (Hanley, 2001).

The problems of monetary valuation of the environment in general (Gregory et al., 1997; Keat, 1997; Joubert et al., 1997; O'Neill, 1997; Sagoff, 1998; Gregory, 2000; Spash et al., 2005; Getzner, 2005) and ecosystem services in particular (Vatn, 2009; Spangenberg and Settle, 2010; Wegner and Pascual, 2011; Keune and Dendoncker, 2014; Kenter et al., 2015) are widely discussed. However, the recent calls for MCDA particularly for ecosystem service valuation demand a detailed evaluation of the potential as well as limitations of MCDA as opposed to monetary valuation of ecosystem services. For example, several authors advocate multi-metric approaches such as MCDA and warn about reducing all value into single metrics like monetary units (Wegner and Pascual, 2011; Chan et al., 2012). However, as we point out later, some monetary valuation methods and some MCDA methods are not fundamentally different in this respect. It should also be noted that MCDA is a family of methods, and individual methods have a different capacity to facilitate deliberative processes and address intangible and incommensurable ecosystem services.

The aim of this paper is to provide a critical yet constructive evaluation of the ways in which participatory MCDA can, or cannot, address the shortcomings of monetary valuation methods within a CBA framework. With *valuation* we refer to processes where people assign importance to ecosystem services, either via stated preference survey methods like Choice Experiment (CE) or Contingent Valuation (CV) in terms of willingness to pay (WTP), or via weighting stage in MCDA. MCDA and CBA are *assessment* frameworks that are used to structure the valuation process and/or present the value information to decision-makers.

In the discussion of the relative merits of MCDA and CBA, and related value elicitation and articulation methods, we start with the more technical differences, aggregated vs. non-aggregated policy options (3.1) and universal vs. context specific utilities (3.2), and proceed to the more complex distinctions, which reflect fundamentally different conceptions of democratic decision-making and human rationality. These include the questions of unitary vs. conditional conclusions (3.3), distributional impacts and income asymmetries (3.4), individual vs. social rationality (3.5), interests vs. ethical judgments (3.6), representativeness (3.7) and biases (3.8). These categories are drawn from relevant literatures (Sagoff, 1998; Vatn, 2009; Spangenberg and Settele, 2010; Wegner and Pascual, 2011) and adopted for the purposes of this paper, which focuses not on the shortcomings of monetary valuation in general, but the key differences between CBA and MCDA frameworks and related methods in ecosystem service valuation.

2. The basic principles of Cost Benefit Analysis and Multi Criteria Decision Analysis

2.1. Cost Benefit Analysis

Cost-Benefit Analysis (CBA) is an economic evaluation method for comparing the costs and benefits of different project or policy options (Pearce and Nash, 1981; Dixon and Hufschmidt, 1986). CBA aims to value all impacts over the lifetime of project alternatives in monetary units, discounted to a specified year, making it possible to screen or rank alternatives by a single monetary measure, often net present value (NPV).

The basic steps of CBA process are (Boardman et al.al., 2011):

1. Definition of the project options to be evaluated
2. Decision on whose costs and benefits are counted for
3. Selection of the measurement(s) and measuring all the costs and benefits
4. Estimation of the outcome of cost and benefits over relevant time period
5. Conversion of all the costs and benefits into a common currency
6. Discounting the costs and benefits into present value
7. Calculation of the NPV for the project options
8. Performing the sensitivity analyses
9. Recommendations based on the NPV and the sensitivity analysis

The aim is to find the most efficient solution by maximizing social welfare, understood as aggregate individual well-being, for a given allocation of resources, land uses etc. In using CBA for decision-making and choosing the alternative with highest NPV, the so-called Kaldor-Hicks criterion states that if those that are made better off can potentially compensate those that are made worse off by the alternative it is Pareto efficient. Even if compensation does not actually take place it is assumed that in aggregate, across all projects, costs and benefits will average out over time and over the entire population. Complete substitutability is assumed, meaning that utilities from different types of project impacts, measured in terms of monetary units, can compensate one another.

There are various methods to estimate benefits of non-marketed goods and services in CBA (Pearce et al., 2006). In discussing monetary valuation we focus on stated preference methods that elicit WTP (CE and CV). In these methods, stated preferences are obtained through representative surveys of the population affected. In Contingent Valuation (CV) technique, the monetary values of the impacts are estimated on the basis of a person's willingness to pay (WTP) in a given currency for achieving a certain environmental improvement, or avoiding a certain deterioration (e.g. in water quality). In Choice Experiments (CE) survey respondents are asked to choose between different project/policy alternatives, described in terms of a number of attributes describing i.e. the level of ecosystem service(s) provided and a price of that alternative to the respondent (Hanley et al., 2001). Representing the confidence bounds of willingness to pay in CBA is encouraged, exploring the robustness of project ranking. Recent examples of CE studies on ecosystem services include a study of stream-related ecosystem services by Allen and Moore (2016), protected areas by Jeanloz et al. (2016) and marine ecosystem services (Hattam et al., 2015).

The underlying assumption of stated preference methods is that people are the best judges of their own well-being and the factors that contribute to it, and that people state their willingness to pay for a