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Selecting a forest plan among alternatives: Consistency of preferences within decision support frameworks

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ABSTRACT

Multi-criteria decision support (MCDS) tools assist the decision maker (DM) in selecting an appropriate option among pre-specified alternatives. In forest management context, criteria based on existing and utilized forest resources are used to compare and contrast the alternatives. Typically only a small group of the available criteria is used in the analysis. Deciding upon which criteria are used to represent the economic, ecological and social sustainability might have an impact on the final selection among the forest plans. This study's primary objective is to examine if DMs derive similar decisions regarding forest management with a varying level of information provided, thus illustrating how critical it is to negotiate about the criteria set in advance. Fifty forest science students were used as testees, using a representative sized forest tract as a case "holding" which provided semi-authentic data. A series of decision scenarios tested how the decision changed with an increase in the amount of information. Results of a systematic examination show that slightly over half of the participants selected the same plan in at least 2 out of 3 scenarios. The results also suggest that the most important requirement for criteria selection is that they display the dimensions where the plans markedly differ.

1. Introduction

Contemporary research into multi-criteria decision support (MCDS) has focused on developing methods and tools which allow for a comparison between alternatives. This comparison focuses on relevant criteria which are – or are expected to be – important to the decision maker (DM). The selection of criteria can be done with guidance from the planning coordinator (Diaz-Balteiro and Romero, 2004; Gómez et al., 2006) or as an independent selection from a list (cf. Kazana et al., 2003; Kajanus et al., 2004).

Identifying the criteria (measurable features of the forest) should be based on their relevance to the DM. Relevant criteria are criteria for which DM has preferences concerning the values those criteria assume. These preferences may be inconsistent, circular or not be very well defined. For individuals with poorly formed preferences, the most appropriate criteria set may evolve as his/her preferences develop. As a result, the initial criteria selected may not correspond to his/her preferences until near the end of the decision process (Beshears et al., 2008). The process of discovering or constructing preferences is itself valuable as it supports learning, promotes awareness of the planning task and contributes to the confidence and satisfaction of the planning process (Leskinen et al., 2009; Hujala and Kurttila, 2010). In participatory planning situations the determination of relevant criteria to be analyzed can be a source of conflict (Mendoza and Martins, 2006). Depending upon the decision support tool, stakeholders may be required to analyze and evaluate the different plans based on the criteria selected for the group as a whole, or the stakeholders may select their criteria independently and then combine the evaluations of the plans (Kangas et al., 2008; Nordström et al., 2009).

While it may appear self-evident that a personal selection of the criteria being evaluated is a requirement for the appropriate use of MCDS tools, this may not necessarily be the case. In forest planning, MCDS tools are generally used when the DM(s) is interested in utilizing the forest for multiple purposes. These tools assist the DM in focusing his/her attention on the tradeoffs which are required, and attempt to quantify the preferences of the individual DM. This is complicated by the multi-faceted issues involved in forestry decisions (Diaz-Balteiro and Romero, 2007) and the difficulties involved in acquiring the DMs' preferences without an influence by the preference elicitation method (Beshears et al., 2008). There are also practical limitations which increase the uncertainty of forest planning. The availability of appropriate inventory data, the inaccuracy of growth models, fluctuating timber prices and various other future uncertainties can limit the feasible options for criteria-based analysis. The costs associated with obtaining data for a specific criterion may be prohibitive and may not provide much additional assistance in the decision making (Kangas, 2010). For these reasons, appropriate substitute criteria might be more suitable in the analysis than the criteria

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participants select for themselves. However, does the analysis lose the link to the DM's own preferences; is the decision analysis scheme robust enough to provide good decision support with substitute criteria?

Conventional economic theory assumes that "each individual has stable and coherent preferences" (Rabin, 1998). However, this assumption differs substantially from how psychological research views how individuals derive their preferences (Kahneman and Tversky, 1982). As a result, individual preferences are notoriously difficult to determine and define. When trying to extract preference information from individuals, there are two main theories as to how the individuals derive their preferences. The first assumes that the individual has a preference for most objects, but these preferences are hidden. The task could be viewed as an archeological project (Gregory et al., 1993), where care must be made in process of uncovering the preference information. The second point of view is that of constructed preferences, where the individuals do not have a well-defined preference, but they create one when asked. Payne et al. (1999) have described this as an architectural process, and have developed a "building code" for measuring these constructed preferences.

The accuracy of preference information depends upon how that information is obtained. Evidence from psychology (Rabin, 1998) and survey methods (Dillman et al., 2009) has revealed that how questions are asked will have a direct impact on the values obtained. Options such as how the question is framed (Tversky and Kahneman, 1981), the presence of anchors (pre-defined initial values, Tversky and Kahnemann, 1974) or cues (an implicit guiding, Slovic et al., 2007) can manipulate the DMs to provide preferences which do not accurately represent their desires. While this type of manipulation impacts the preferences obtained, it does not invalidate them. For instance, Ariely et al. (2003) have shown that while the absolute valuation of preferences is quite arbitrary and is strongly influenced by how the question is formed, the relative preferences appear orderly.

There are three primary objectives in this study. The first is to determine if DMs are able to select similar forest plans with varying levels of information regarding the plans. Since some forest statistics are highly correlated (i.e. volume harvested and total income), it is expected that the DM could make similar decisions with less information. This is accomplished through simulating the decision making framework several times, and during each of the iterations a different amount of information provided. The second is to determine if testees falling within different forest owner groups with respect to the objectives of ownership make decisions regarding the forest plan in distinctive ways. Perhaps those DMs who share similar ideals about the forest would make similar decisions regarding the planning of forest operations. The third objective is to determine if there are differences in the DMs' preferences toward decision support. A single decision support tool will not fit the requirements of all DMs, as some DMs may prefer linguistic support over numeric or vice versa.

2. Materials and methods

2.1. The participants

The decision support experiment was conducted on forestry students, who had just completed their first year from the University of Helsinki (UH) and University of Eastern Finland (UEF). All of them participated in a voluntary manner in the experiment as test subjects. The students' major topic differed, however the first year of forest education in Finland is rather common between majors. An initial pilot study was conducted with 18 students, to test the feasibility and other practical issues of the experiment (Eyvindson et al., 2010a). The data used in this study came from two additional experiments conducted with students during a forest planning course held by UH and UEF.

In total the experiment was conducted on 50 participants, 28 from UH and 22 from UEF. The age of the participants ranged from 20 to 31 years, with an average age of 23.1 years old. Approximately two-thirds of the participants were male, and one-third was female.

2.2. The decision support experiment

The experiment was conducted in two phases (Fig. 1); the first phase started with a briefing to the participants on the size, species composition and inventory of the case study forest holding to ease them to think of themselves as the owners of the holding. By using a single forest holding, it was possible to fix the properties of the plans, and focus on the decisions made by each testee.

First a brief presentation was given to all participants highlighting the experiment and describing the forest holding. Participants then filled out a questionnaire designed to sort the participants into potential ownership categories with respect to objectives of forest ownership (see Favada et al., 2009). The questionnaire, and the method sequence for creating ownership groups, has been used in a similar way in earlier studies which analyzed the Finnish private forest owners (Karppinen et al., 2002; Favada et al., 2009). The four-group typology used in this analysis is similar to Karppinen et al. (2002): Multiobjective owners who desire both economic value and recreational value from the forest; Recreationalists who emphasize the recreational value of the forest; Self-employed owners who prioritize employment and labor from the forest; and Investors who view the forest in economic terms, providing income and economic security.

Each respondent answered a series of 22 Likert scale questions which represented monetary, recreational, spiritual, conservational, and esthetic motives. A principal component analysis (PCA), which is a statistical approach which analyzes a large number of variables and explains them by a small number of factors (Hair et al., 2006), allowing for three explanatory factors was conducted on the responses to the questions. Then each participant was separated into one of four different ownership groups through a k-means cluster analysis. A cluster analysis is a multivariate technique which groups objects based on their similarities (Hair et al., 2006).

The second phase was a series of three decision scenarios which used different levels of information regarding the forest plans. In each of the three scenarios, the respondents were to select the most

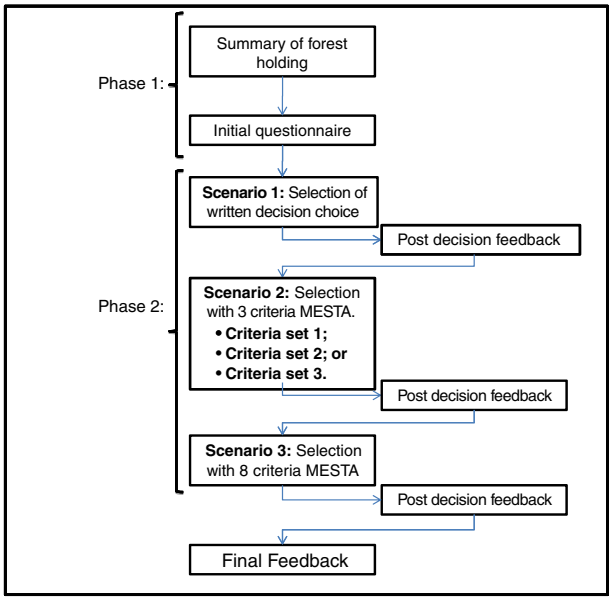

Fig. 1. Flow chart of the experiment.