Forest Policy and Economics 11 (2009) 1–9

Contents lists available at ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

Mesta: An internet-based decision-support application for participatory strategic-level natural resources planning

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ARTICLE INFO

Article history:
Received 3 October 2007
Received in revised form 17 April 2008
Accepted 2 July 2008

Keywords:
Forest planning
Participatory planning
Natural resources
Preferences
Trade-offs
Evaluation

ABSTRACT

We tested the Mesta Internet-based decision-support application in connection with a natural resources planning (NRP) process in Eastern and Western Lapland, Finland. The aim in this process was to define the land-use allocation and the corresponding forest management operations for state-owned forests within these planning regions. Mesta was used in examining and evaluating the strategy alternatives from the viewpoint of the stakeholders' objectives. The basic idea in using Mesta is to define the acceptance thresholds that divide the alternatives into 'acceptable' and 'not acceptable' alternatives with respect to each decision criterion. The thresholds are adjusted holistically, i.e. so that all decision criteria and criteria values of all decision alternatives are simultaneously visible from the user interface. The holistic adjustment process is continued until an acceptable solution compliant with the production possibilities of the planning area is found. In the NRP process, the members of the stakeholder group first used Mesta individually to set their own thresholds. Next, the participants' acceptance thresholds were combined and a negotiation process was launched to find the group's common acceptance thresholds. This negotiation was also supported by Mesta. The result of the negotiation was that the participants were able to collaboratively decide on their recommendation for the future land-use allocation and the forest management principles to be applied in the two planning regions. The main benefit of Mesta as a decision-support tool during the negotiation process of the group was that the participants were forced to merge their preferences with the realistic production possibilities of the planning regions.

1. Introduction

The allocation and management principles of natural resources on a wide geographical area and over a fairly long time period are typically tackled and decided upon in connection with strategic-level planning processes. Furthermore, often only a few interesting alternative strategies are generated and evaluated during the planning process (e.g. Pykäläinen et al., 1999; Kangas et al., 2001a; Hiltunen et al., 2008). The uncertainties related to the development of the operational environment and in forest inventory data, planning calculations and estimation of the decision-makers' and other parties' objectives are reasons for keeping the number of alternative strategies small. Due to the quite limited number of alternatives, strategic forest planning is in most cases basically a discrete choice problem.

Strategic decisions on the utilization of natural resources can have significant impacts on local communities, local people's livelihoods, and many other forest-user groups. Many stakeholders and interest groups have their own issues in these planning processes, because the results affect different groups differently (e.g. Martin et al., 2000; Hytönen et al., 2002). Hence, participatory strategic-level planning has in many countries become an important tool for promoting sustainable forest management, particularly in publicly (state-) owned forests (e.g. Buchy and Hoverman, 2000; Sheppard, 2005). Stakeholders and interest groups such as forest-industry, forestry-policy organisations, forestry entrepreneurs, labour unions, municipalities, and recreation and nature protection organisations are normally involved in the processes.

The primary goal of participatory planning is to enhance social sustainability. Social sustainability is often interpreted to include the employment of local people, the status and living conditions of indigenous people, as well as wide participation possibilities in the planning process, and the broad acceptance of its results. In addition,

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doi:10.1016/j.forpol.2008.07.004

participatory planning may be used in mapping out the risks of conflicts between the different participants and avoiding unnecessary conflicts, sharing information between participants, and promoting good relationships in the operational environment of the planning organization (e.g. Hellström, 2001; Kangas and Store, 2003).

Traditionally, the preferences of local citizens and other interest groups have been collected by means of mail inquiries, interviews, etc. (e.g. Loikkanen et al., 1999; Wallenius, 2001). However, it is evident that these methods do not significantly enable collaboration nor interactive learning. They do serve in the collecting of opinions and messages from the population of the planning area, and these are certainly also valuable. However, their utilization in the strategic planning process is not straightforward, and may call for specific analyses (e.g. Hytönen et al., 2002). Moreover, collecting this information and its further analysis can be costly. It can be argued that these approaches do not provide very in-depth and exploitable material that would efficiently support the creation of strategy alternatives or their evaluation, for example.

Metsähallitus, as the manager of state-owned forests in Finland, launched systematic public participation undertaking in the middle of the 1990s. The preferences of local people were collected mainly through enquiries and public meetings in planning processes (Wallenius, 2001). About 1% of the local people were found to be interested in Metsähallitus' affairs and gave some feedback. The feedback was largely related to local site-specific questions and to some popular topics such as hunting possibilities on Metsähallitus' lands. As such, the preference feedback was valuable, but useful mainly in operational planning. From the point of view of strategic planning, the value added of this feedback was rather limited. As a result, Metsähallitus started to involve stakeholder groups in NRP processes about 10 years ago.

As regards stakeholder group work, different multi-criteria decision-support (MCDS) methods have been applied (e.g. Pykäläinen et al., 1999; Kangas et al 2001a,b; Pesonen et al., 2001). A multi-attribute value theory (MAVT) application called Interactive Decision Analysis (IDA) was used in the first NRP process in the Kainuu region of Finland (Pykäläinen et al., 1999). The use of IDA consists of: (i) construction of a decision hierarchy, including decisions on the relevant criteria; (ii) definition of sub-utility functions for the selected criteria; and (iii) criteria weighting. The created strategy alternatives are at the lowest level of the hierarchy. However, in most NRP processes the strategies were worked out without systematic use of MCDS methods, simply by analysing the planning problem from different viewpoints and searching for a common solution through discussions and negotiations (see also Kangas et al., 2001a).

Voting methods based on the ordinal scale (e.g. Kangas et al., 2001a,b) were applied in the second round of NRP, launched in 2002 at Metsähallitus, along with MAVT methods. For example, approval voting (AV) (Brams and Fishburn, 1983), the Borda count method (Saari, 1994), and cumulative voting (Blair, 1973) were used to select the evaluation criteria and to define their importance order in the second NRP process in Kainuu in 2003 (Hiltunen et al., 2008). Finally, multi-criteria approval (MA) (Fraser and Hauge, 1998) was used to evaluate the strategy alternatives. The complementary use of voting methods and an MAVT decision-support model was tested in connection with a recent NRP process in Western Finland (Pykäläinen et al., 2007). In the said process, the strategy alternatives were first ranked by using the MA method and then analysed more specifically by means of interactive utility analyses.

Experiences from these processes show that the use of MCDS methods provides several benefits (for more details, see also Kangas et al., 2001a; Kangas and Kangas, 2005). Firstly, their use makes the analysis of the importance of the criteria and the evaluation of the strategy alternatives more transparent. Secondly, the efficiency of the stakeholder group work is improved, because the discussion concentrates more on “the essentials”, i.e. on the evaluation of the alternatives and their priorities. The benefits of particularly MAVT-based methods include illustrative presentation of the results of analysis and possibility for various sensitivity analyses as well as wide possibilities for preference elicitation (e.g. Saaty, 1980; Keeney and Raiffa, 1993; Barzilai and Lootsma, 1997; Kangas et al., 2001a; Pykäläinen et al., 2007; Hiltunen et al., 2008).

On the other hand, the use of the MAVT methods may be challenging for some participants with respect to the preference elicitation and evaluation of the outcomes of the model. In addition, the formulation of sub-priority models, for example, may require assistance from experts, and a planning consultant is needed to formulate the model (e.g. Pykäläinen et al., 2007). It may also be difficult for participants to understand how the model really works and to be able to utilize the input parameter values. All these mean that several common meetings are needed involving the group and the experts, and this can increase the costs of the planning process. Some group members and experts may have difficulties in participating in all the necessary meetings. Concerning voting methods, their principles may be easier to understand, but the possibilities for sensitivity analyses are limited. In addition, they may not be able to expose the clear winner candidate and some of them can be manipulated (e.g. Pykäläinen et al., 2007; Kangas et al., 2008).

The Mesta Internet-based approach for NRP was developed as a response to the challenges listed above. In this study, we report its use in a real-life multi-objective participatory planning process. In particular, the use of Mesta in this situation aimed (i) to improve the cost-efficiency of the NRP process through the use of an application that can be used individually by stakeholder group members over the Internet; (ii) to improve interactive learning by offering more time to examine the alternatives and the interdependencies between the decision criteria; and (iii) to provide a new kind of decision support for the group negotiation process. By presenting the application in a real-life multi-objective participatory planning process, we aimed to bridge the gap between theory and practice.

2. Description of the Mesta Internet-based decision-support tool

2.1. Theoretical background of the Mesta application

The theoretical background of Mesta corresponds to the functional idea of *feasible region reduction methods*. Feasible region reduction methods originate from interactive mathematical programming algorithms developed for multi-objective problems where the number of decision alternatives may be very large (Steuer, 1986).

When applying feasible region reduction methods, the optimization and constraints of the problem are included into the planning model, which is usually formulated to a form of a mathematical programming problem. The constraints of the problem are iteratively reformulated until the DM is satisfied with the result. At the same time, the participant progressively defines his or her preferences. Steuer (1986) describes the selection of the best alternative in feasible region reduction methods as follows: “The DM will pick the point with which he or she feels most comfortable as the final choice”. Furthermore, Steuer (1986) allocates the feasible region reduction methods to the category of *ad hoc* methods. This means that the DM proceeds primarily “instinctively” in his or her interactive problem solving process.

When using Mesta in participatory forest planning, the planning participants do not deal with mathematical problem formulations. Instead, limited number of alternative plans is produced in advance by using e.g. GIS operations, linear programming or other available optimization methods. After creating the set of alternative plans, the participants start the interactive reduction of the feasible set of alternatives by utilizing the information about the consequences of the alternatives. Mesta provides an illustrative Internet-based user interface for carrying out this task.