Hydrol. Earth Syst. Sci. Discuss., 10, C4955–C4958, 2013
www.hydrol-earth-syst-sci-discuss.net/10/C4955/2013/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "A decision analysis framework for stakeholder involvement and learning in groundwater management" *by* T. P. Karjalainen et al.

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Received and published: 13 September 2013

Reviewer #2 has offered an expanded version of his/her comments, which are being posted by the Editor:

Reviewer #2 expanded comments:

Comments on A Decision Analysis Framework for Stakeholder Involvement and Learning in Groundwater Management, by Karjalainen et al.

This article presents a case study of the use of formal decision analysis methods to help a fractious stakeholder group reach agreement on a protection plan for the Rokua

esker aquifer in Finland. Overall, the execution of this decision analysis project was excellent. Key strengths of the case study include the engagement of a relatively large number of stakeholders (19 in all) representing diverse interests; the participatory method used to structure the decision problem (for example, involving all stakeholders in constructing the value tree and critiquing the alternatives under consideration); and the interactive interview process employed to elicit attribute weights for the multi-attribute utility (MAU) function. In addition, the article is very well written. The authors describe very clearly the problem context, methods, and results. This paper presents the opportunity to publish one of few practical applications of decision analysis concepts in the management of natural resources. While decision analysis techniques have long been used to support business management decisions, published applications in the field of natural resource management are quite rare. For example, a systematic review by Keefer et al. of decision analysis applications articles published between 1970 and 2001 identified 171 articles in total, but only five of those dealt with environmental management.(1) This article therefore provides a valuable contribution to decision analysis literature in an application area that currently is insufficiently represented. While the article could be published as is, ideally it would be strengthened by addressing some potential limitations of the multi-attribute utility model, by adding a pre-post evaluation of the participants' decision preferences, and by adding a brief discussion of the outcomes of the decision process, in comparison to decision outcomes reported in other decision analysis case studies. Below, I offer specific suggestions in each of these areas.

1. Form of the Multi-Attribute Utility Model

a. The authors develop an MAU model that is a linear function of seven attributes (change in water level, chemical state of lakes, etc.). However, they should have formally checked that the linear model is appropriate for describing the preferences of these stakeholders. In order for such a linear model to provide a mathematically valid representation of preferences, the attributes must satisfy the additive indepen-

dence condition, described in a number of classic decision analysis texts (for example, Keeney and Raiffa, 1976, von Winterfeldt and Edwards 1986, and Clemen and Reilly 2001).(2–4) The authors should use the techniques described in these texts to establish whether or not the seven attributes are additively independent. If they are not, then a different form of utility function (for example, perhaps including interaction terms) may be needed.

b. The authors assume each single attribute utility function is linear. Such a linear assumption assumes the participants are risk neutral and may not be appropriate. The authors should elicit individual utility functions for each attribute, in order to test whether the linear assumption is valid. An alternative would be to test the robustness of the resulting rankings of the three decision alternatives under various commonly encountered nonlinear functional forms.

c. Ideally, the authors would have developed quantitative measures to describe the four attributes that currently are characterized with categorical scores. These four attributes are (1) chemical state of lakes, (2) chemical/ecological state of springs, (3) income loss for peat production, and (4) attractiveness for tourists. For example, it should have been possible to estimate specific peat-related income losses for each decision alternative in Euros, instead of using the categories -, 0, +, and ++. Similarly, attractiveness for tourists could have been estimated as changes in tourism revenue. Appropriate chemical or ecological indicators could have been determined for the other two attributes, as well.

2. Pre-Post Evaluation

Figure 8 shows the results of a questionnaire administered to participants after the decision analysis process. Missing from this is any indication of whether the participant's preferred alternative changed as a result of participating in the decision analysis workshops. If possible, the authors should develop a very brief survey that could be administered to the 19 participants asking whether engagement in the decision analy-

sis process changed their preferred alternative. The questionnaire should be carefully designed to minimize recall bias.

3. Comparison of Results with Larger Literature

One of the most striking results from this work is that although the stakeholders represented divergent interests with different priorities, the MAU model for each of these participants identified Alternative C as the preferred choice, as shown in Figure 6. The authors should comment on whether this result could be an artifact of functional form flaws in the MAU model (for example, failing to consider nonlinearity in individual attribute utilities and/or interactions among attributes). Also, the authors should comment on how this particular finding (the MAU process leading all 19 stakeholders to the same preferred alternatives) is common or rare in the decision analysis application literature.

References

(1) Keefer, D. L.; Kirkwood, C. W.; Corner, J. L. Perspective on Decision Analysis Applications, 1990?2001. Decision Analysis 2004, 1, 4–22. (2) Keeney, R.; Raiffa, H. Decisions with Multiple Objectives; Wiley: New York, 1976. (3) Von Winterfeldt, D.; Edwards, W. Decision Analysis and Behavioral Research; Cambridge University Press: Cambridge, 1986. (4) Clemen, R. T.; Reilly, T. Making Hard Decisions; Duxbury: Pacific Grove, California, 2001.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 8747, 2013.