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Behavioural issues in environmental modelling – The missing perspective

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ABSTRACT

The paper aims to demonstrate the importance of behavioural issues in environmental modelling. These issues can relate both to the modeler and to the modelling process including the social interaction in the modelling team. The origins of behavioural effects can be in the cognitive and motivational biases or in the social systems created as well as in the visual and verbal communication strategies used. The possible occurrence of these phenomena in the context of environmental modelling is discussed and suggestions for research topics are provided.

1. Introduction

Every environmental model embeds behavioural issues related to the modeler. Modelling is not about models only. It matters how we choose the models and how we work with the models. In a recent paper (Hämäläinen et al., 2013) we introduced the term Behavioural Operational Research (BOR). It refers to research which considers the human impact on the process of using operational research (OR) methods in problem solving and decision support as well as using OR methods to model human behavior. We pointed out the need to take into account effects caused by mental models and cognitive biases as well as social systems created and communication effects. In participatory problem solving and decision making the way the interaction and communication is carried out becomes important and has an effect on the dynamics of the problem solving process. This can influence the behavior and preferences of the participants (see e.g. Slotte and Hämäläinen, 2015). For the modeler it is useful to view such social processes as systems in which she is an active player (see e.g., Hämäläinen and Saarinen, 2008 and Luoma et al., 2011).

The aim of this paper is to bring behavioural issues and perspective into the discourse taking place in the environmental modelling community too. Because of the complexities of the problems in environmental management the focus is easily narrowed down to seeking the best model only. Listing different types of modelling approaches and their technical merits and weaknesses is not enough as it can leave us ignorant of the problems and risks related to the way the models are used and implemented. For example, the recent position paper by Kelly et al. (2013) has a very extensive discussion of modelling approaches but does not consider the modeler risks in these approaches. There are many studies related to uncertainties in environmental modelling and impact assessment (for a review see, e.g., Refsgaard et al., 2007). There is also literature on uncertainties due to model structure error (Refsgaard et al., 2006) but very few studies on the uncertainties related to the skills and behavior of the modeler. The review of Matott et al. (2009) includes a note on Wheeler effects which refers to the difficulty of recognizing one's incompetence (Kruger and Dunning, 1999). Linkov and Burmistrov (2003) consider explicitly modeler bias and the role of expert opinions. The literature on expert judgment is also important as it considers ways to use expert opinion in modelling. This topic has been discussed in connection with environmental modelling by Krueger et al., 2012. The rapid increase of the use of multicriteria modelling in environmental decision making (see, e.g., Herath and Prato, 2006; Linkov and Moberg, 2012) has helped to deal with the values and goals of the participants. One of the main reasons for using

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MCDA methods in group processes is that the participants' values can be dealt with in a transparent way (Salo and Hämäläinen, 2010). However, the question how values are related to behavioural issues in model use has not received much attention. Values can also be the drivers in motivational biases.

This paper introduces behavioural phenomena which can be relevant in the practice of modelling. There is very little research on the modelling of the modeler or on modeling the effects of these phenomena. How to avoid these behavioural effects, e.g., by debiasing is an open research question. This is a very interesting but difficult theme discussed so far only to some extent in the area of decision analysis (see, e.g., Lahtinen and Hämäläinen, 2015; Montibeller and v. Winterfeldt, 2015).

The need and interest to consider behavioural effects and biases has been recognized in other disciplines when their theoretical core has matured enough. Such examples are economics, game theory and finance. In these areas the original theoretical models and results were based on idealized assumptions about human behaviour, e.g., profit maximization, which are not always followed in the real behaviour of people. Today there is strong interest in analyzing economic decision making experimentally. Understanding the reasons for the choice behaviours observed has become the focus of research. The questions of interest include, for example, are people self-regarding or other regarding and what explains investor behaviour which does not reflect expected utility maximization. The introduction of more realistic assumptions about peoples' "behaviour aims to better theoretical insights and predictions for better policies" (Camerer and Loewenstein, 2004). The discussion of behavioural effects has also reached environmental economics (Shogren and Taylor, 2008). Environmental modelling is a mature field too and it is now natural to pay more attention to behavioural effects. The main goal of considering behavioural issues more carefully in environmental modelling is also to improve the understanding of decision processes and to produce better predictions, decisions and policies. The importance of modelling in helping to understand and manage environmental problems is widely accepted. Models are being used in an ever increasing pace and in the crucial problems of mankind. But how often do we ask about the possible behavioural issues and problems in the process of generating and using the models? There are best practice guidelines but we need more understanding about how and what can go wrong due to behavioural issues originating from the modeler, participants or the system of problem solving created.

2. Modelling

The book Limits to Growth by Meadows et al. published already in 1972 is among the pioneering work in the field of environmental policy modelling. The authors worked in the MIT Systems Dynamics Community which had understood the risks in modelling (Sterman, 1991, 2002). However, it seems that the widespread use of modelling has left these issues with less attention. Environmental researchers often have their background in the natural sciences. This easily anchors us, or at least the novice modeler, with the idea that models are true and accurate descriptions of the reality even if models are sometimes also used only to give structure to the phenomena studied (Hämäläinen et al., 2014a, b). Accuracy of description is naturally the goal when we aim to explain phenomena and characterize environmental systems. However, when models are developed to manage or solve problems the issue of validity becomes a different question. The purpose for which the model is developed is reflected in the parameters and scales as well as in the level of detail used. Sterman (2002) used the phrase "All models are wrong" in the title of his famous paper in which he emphasizes the balance of assumptions with the intended use of the model. The phrase had already earlier been used in the context of statistical modeling (Box, 1976) when emphasizing the interplay of practice and model development. The main message of Sterman is that model boundaries and the level of detail used in the description depend on the intended use of the model. There is not a single valid model fitting every purpose. Today, these principles are indeed emphasized in the field of environmental modelling too (Jakeman et al., 2006; Harmel et al., 2014). This naturally leads to ask the question how well do we modellers succeed in matching the model with its intended purpose.

In considering the behavioural effects we should take a humble approach and accept the fact that we are not likely be able to produce a "perfect" model but still could find one that is useful. Sometimes the usefulness of a model is not about accuracy (Bennett et al., 2013) but it can also be evaluated, for example, by taking into account the learning acquired during the process of building the model both by the modelers and the problem owners (Jakeman et al., 2006; Senge et al., 2008). Learning and improved communication are often reported to be the most important benefits especially in participatory multicriteria and system dynamics approaches (van den Belt, 2004). In these situations, the modeler behaviour in the interaction becomes important. The modeler should not only be focused on the perfection of the accuracy of the model, but the process and communication counts a lot too (Marx et al., 2007). It would be preferable to use models in a facilitated mode rather than in an expert mode (Franco and Montibeller, 2010). Today, there is increasing interest in understanding peoples' ways of thinking and deciding in different settings. We are suggested to have two ways of thinking, fast and slow or system 1 and system 2 (for a discussion see Kahneman, 2011). How is this reflected in the participative decision making proce? For us modelers this can also be of interest. When is fast or slow reasoning process the desired one and can the use of models help in stimulating either one?

Best practice papers like the one by Black et al. (2014) focus on the process and acknowledge that a valid model can be used in different ways. Thus the human behavioural impact is indeed recognized. See also the discussion on model validity in Refsgaard and Henriksen (2004). So far, we have very few comparative analyses of the pros and cons of alternative best practices (for some examples see French et al., 1998; Brocklesby, 2009; Marttunen et al., 2015). There are no meta-level analyses how different modelers have succeeded in following the best practice guidelines. The implicit assumption in best practice approaches seems to be that model users are good willed and able to avoid psychological biases in their own practice. The idea of the existence of one ideal process can still prevail. The modelers need to acknowledge the fact that different modeling processes can lead to different outcomes. For a discussion of path dependence in modelling and the related drivers see Hämäläinen and Lahtinen, 2015. Behavioural issues are also closely related to ethical issues. Ethics in modelling has been discussed extensively in the OR literature (Wallace, 1994; Rauschmayer, 2001; Gass, 2009; Walker, 2009; Ormerod and Ulrich, 2013). It is noteworthy that most of these discussions provide guiding principles but few real cases are analyzed retrospectively (Brocklesby, 2009) and no experimental analyses of the success of following the guidelines are reported.

The discipline of Integrated Environmental Modelling (IEM) has an explicit aim to integrate transdisciplinarity into solving complex real world problems (Laniak et al., 2013). The field emphasizes that it is science based. Its idea is to use interdependent models components related to different aspects of the problem including the environment and human systems. In evaluating the IEM process (see, e.g., Schwanitz, 2013) the belief in the existence of an ideal correct model can remain when the science based characterization