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Participatory modelling for sustainable development: Key issues derived from five cases of natural resource and disaster risk management

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ABSTRACT

Stakeholder participation is considered a key principle for sustainable development in the context of natural resource and disaster risk management. Participatory modelling (PM) is an interactive and iterative process in which stakeholder involvement is supported by modelling and communication tools. Planning and decision-making for sustainable development (SD)integrate three *substantive* dimensions − social, ecological and economic. The *procedural* dimension of SD, however, is equally important, and here we see great potential for PM. In this study, we evaluate five PM research projects against criteria for the *procedural* dimension of SD. This provides a basis for identifying key issues and needs for further research into PM for SD. While the cases show great potential, especially for supporting knowledge integration, learning and transparent handling of values and perspectives, they indicate a particular need to develop PM in respect of organizational integration. This issue is closely connected to the possibility of effectively implementing PM in practice.

1. Introduction

In the last few decades, policy analysis studies have identified the importance of stakeholder participation of relevant actors to ensure sustainable natural resource and disaster risk management (Biswas, 2005; White et al., 2010; Vojinovic and Abbott, 2012; Newig et al., 2014). New policy documents and legal frameworks in the area underline these requirements of participatory governance (e.g. Aarhus convention, EU Water Framework directive, Environmental Impact assessment Directive).

Planning and decision-making to ensure SD imply integration of the three pillars − social, ecological and economic (Robinson, 2004; Ginson, 2006) − the *substantive* dimensions of SD (Robinson, 2004). In order to achieve such integration, however, the *procedural* dimension of SD is equally important to consider (*ibid.*). A sustainable procedure can be described as a political conversation[1] of desirable futures, informed by scientific knowledge from a broad range of effectively integrated disciplines (Robinson, 2003; McMichael et al., 2003; Clarke and Dickson, 2003), as well as by the knowledge and perspectives of those actors variously affected by the plan or decision in hand (Ostrom, 2009; Vaidya and Mayer, 2014).

Against this background, we see great potential for Participatory Modelling (PM) − an interactive and iterative process in which participatory planning is supported by computer-aided modelling and other types of communication tools. One of the main reasons for its potential is that PM supports the integration of scientific and contextual knowledge by developing a joint knowledge base which leads to social learning in a pre-defined process of interaction between scientists and/or civil servants and local stakeholders (Pahl-Wostl et al., 2007). It is also argued that these types of efforts are able to bridge the science-policy gap, if framed systematically (Smajgl et al., 2013). Another important and interlinked argument is that PM may help to manage complex and wicked problems (Davies et al., 2015). PM assists joint decision-making by opening up and defining different perspectives and solutions that may include compensation for those negatively affected. PM also involves a thinking process which takes both the dynamics of scientific knowledge development and the political decision-process into consideration; this can increase trust in and the legitimacy of the process (Becu et al., 2008). Furthermore, PM supports the development of a local participatory management structure, and by safeguarding important democratic values it may improve the long-term handling of our natural resources (Etienne, 2014).

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[1] By political conversation we mean that the conversation involves consideration of values and value trade-offs.

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Table 1
Outline of the theoretical framework used. For a complete description, see Hedelin (2007, 2015a, 2016).

Key sustainability principle	Generating theme	Criteria Sustainable planning processes have to include, support or promote …	
Integration	…across disciplines	A	integration of knowledge from all relevant disciplines.
		B	handling of different views of knowledge (e.g. positivist, relativist).
		C	handling of different kinds of uncertainty.
	…across values	D	identification of the most relevant values in relation to the current issue.
		E	rational argumentation: relating identified values to alternative choices in the planning process.
Participation	…contributing to the process	F	inclusion of knowledge owned by relevant actors.
		G	inclusion of the ideological orientations represented by relevant actors.
		H	participation in the most critical phase(s) of the process.
	…generating commitment, legitimacy or acceptance	I	a procedure for defining the actors that should be involved.
		J	handling of power asymmetries.
		K	Procedures that ensure that ideological orientations are not suppressed (for consensus-based approaches).
		L	stakeholder learning.
Integration	…across organizations	M	organizational learning.
		N	handling of the formal planning context.
		O	handling of incentives, including resources and efficiency (removing of thresholds).
		P	handling of human aspects coordination (trust, engagement, conflict management).

The aim of this study is to contribute to a baseline for research on how PM can be used as a tool for sustainable processes in the context of wicked problems such as natural resource and disaster risk management. We apply a theoretical framework for sustainable development as process (Hedelin, 2007, 2015a, 2016) to five large PM projects in order to present a theory-based and in-depth synthesis and evaluation of the cases, and to indicate key functions and issues for PM as a tool for sustainable processes.

Using models in a stakeholder process has been given different names, including 'mediated modeling' (Van den Belt, 2004), 'companion modeling' (e.g. Barreteau, 2003), 'group model building' (Andersen and Richardson, 1997), "collaborative modelling" (John et al., 2014; Niswonger et al., 2014) as well as the more generic 'participatory modeling' (Voinov and Bousquet, 2010). The body of scientific literature in this field has grown steadily during the last decade and now includes different levels of ambitions of model-tool complexity and of stakeholder involvement (Seidl, 2015). These efforts are in what can be named participatory research, in relation to which Cornwall and Jewkes already in 1995 pointed out the diverse interpretations of the concept of participation and requested greater stringency in qualifying the meaning of participatory research (Cornwall and Jewkes, 1995). Inspired by Probst and Hagmann (2003) and Biggs (1989), Barreteau et al. (2010) have categorized these efforts into four different levels of participation, namely collegiate, collaborative, consultative and contractual participation, during which control over the research process shifts from local people to scientists.

PM, as we define it here − an interactive and iterative process in which a participatory planning process is supported by computer-aided modelling and other types of communication tools − is in line with all the approaches mentioned above. Importantly, PM applies here not only to joint development and usage of computer based models representing different aspects of the physical/natural system, but also to the engagement of stakeholders[2] and other actors in a decision-making process. Such a process can include, for example, base-line analysis, goal definition, simulation, scenario analysis, designing and testing measures, and the selection of alternatives (cf. Jonsson et al., 2005; Andersson et al., 2010; Alkan Olsson et al., 2011; Evers et al., 2012a, 2012b; Jonoski and Evers, 2013).

2. Method and theory

The authors' collective experiences from five large PM research projects (described below) provide the empirical basis for this analysis (Jonsson et al., 2005; Alkan Olsson et al., 2011; Jonsson and Wilk, 2014; Wilk and Jonsson, 2013; Evers et al., 2012a, 2012b). This in-depth approach and the theoretical perspective applied (described below) facilitate a reflective, critical research approach and permit the systematic inclusion of experiences that have not previously been reported from the individual case studies.

The cases are analyzed using the sustainable procedure framework (SPF),[3] developed and applied in the context of natural resource and disaster risk management. There are a number of participatory frameworks and best practice guidelines for participation and PM in literature, such as Hassenforder et al. (2015), Perez et al. (2014), Smajgl and Ward (2013), Korfmacher (2001) and Barreteau et al. (2010). Compared to these, the SPF allows for (simultaneously):

- studying PM explicitly in relation to the concept of SD,
- a focus on procedure (compared to output, e.g. a management plan, an implemented measure),[4]
- a theory-based analysis,
- a critical perspective (due to the deductive and normative character of the SPF),
- a governance perspective on PM (due to inclusion of issues such as representation and organizational integration).

The SPF is intended for the development and assessment of natural resource and disaster risk management procedures at national, regional and local levels and typically in river basin management and municipal land use planning. See Table 1 for an outline.

The framework has been developed as a response to the need for establishing ways to explicitly and systematically relate practical planning and decision-making procedures to the concept of SD. The difficulty of relating a specific practice to the abstract and theoretical concept of SD is well recognized (Robinson, 2004; Chesson, 2013). The approach uses two SD-principles – Integration and Participation – as a first step to implementation. These are both well-established principles of SD procedure and by far the most cited in both natural resource and disaster management (see for example Gregersen et al., 2007; Campbell and Sayer, 2003; Henriksen et al., 2009; Sawhney et al., 2007). Based on these principles, a set of criteria has been derived that describes the constituents needed for an integrative and participatory procedure.

[2] Stakeholders are those who are affected by a planning or decision-making process, and can include lay people, representatives for different types of organizations, as well as decision-makers and civil servants.

[3] For a detailed explanation of the SPF and how it is derived, see Hedelin (2007, 2015a, 2016).

[4] The process and its outputs are strongly dependent, and the value and function of the resulting plan or measure depends on the quality of the process.