How participatory can participatory modeling be?
Degrees of influence of stakeholder and expert perspectives in six dimensions of participatory modeling

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Abstract
The authors are involved in a project aiming at the development of a methodology for participatory modeling as a tool for public participation in water resource management. In this paper, some examples of different degrees of stakeholder influence in six key dimensions of participatory modeling are identified and discussed. Arnstein’s A ladder of citizen participation. Journal of the American Institute of Planners, 1969, 4, 216–224 critical discussion of different degrees of “real” decision-making power is taken as a point of departure to assess possible degrees of stakeholder influence. Can we as participatory modelers be sure that we are really inviting our research objects to an equal communicative relationship where local perspectives, knowledge and priorities are respected to the same extent as central and/or expert perspectives? This paper presents an approach that could be used as a tool for structured reflection to avoid unreflective tendencies towards expert knowledge dominance and low degree of stakeholders’ real influence over the process.

Keywords Model assisted dialogues; participatory modelling; participatory water management; stakeholder involvement

Introduction
The involvement of stakeholders is today seen as crucial for the mitigation of environmental problems. This is also acknowledged by the EU directive on water (Council of the European Communities, 2000) which strongly emphasise the potentials and need for increased stakeholder participation in water management. Public participation may contribute to achieving several interrelated goals such as better-informed stakeholder groups, transfer of knowledge and information from local stakeholder groups to regional and national planning and research, socially accepted mitigation measures (leading to higher efficiency in implementation) and reduction of conflicts between stakeholder groups (Lauber and Knuth, 2000; Pahl-Wostl, 2002).

Although models present a simplification of complex systems, they can be considered as a useful tool to enhance understanding of the behaviour of systems at the catchment and river-basin scales. Outputs from scenario-impact analyses put environmental changes in a tangible spatial and temporal perspective and may serve as a basis for effective planning and mitigation. Moreover model-derived information can be used to minimise the risk that discussions are blocked by biased perceptions of the causes of prevailing environmental conditions and of the potential impact of remedies. It can also make it possible for actors to see where their views and interests conflict, and how they can be bridged.
The authors are involved in a project aiming at the development of a methodology for participatory modeling (DEMO) as a tool for public participation in water resource management. The process involves farmers, owners of rural households not connected to wastewater treatment plants and local authorities within the drainage area of the Kaggebofjärden in Sweden, draining into the Baltic Sea. The methodology is based on a sequence of dialogues between stakeholders and experts, where a catchment model of nitrogen and phosphorous flow serves as a platform for the establishment of a common view of present conditions and the causes behind these conditions. The dialogues also include model-assisted discussions to establish an agreement on environmental goals, and on a remedy plan aiming to reduce nutrient transport to the Baltic Sea, assisted by scenario modeling with consideration to both environmental impacts and the costs of various remedies.

Traditionally, scenario production has been used as a one-way communication of results from scientists to stakeholders. A strict “science-based” approach that stresses optimal utilisation of water resources from a natural scientific and/or economical perspective may not be perceived as beneficial by all stakeholders or policy makers, neither at the super-local, local nor regional level. To guarantee that scenarios will be seen as a legitimate tool in the mitigation process, stakeholders at different levels must be involved in the validation of the input and outputs from the models. As argued by Schulze (2001) the use of models as a policy-making tool makes it necessary for scientists to adapt from a “research thinking” to a more outcome based “policy thinking” to fit the needs and demands of stakeholder groups involved in a policy process.

By involving stakeholder groups in several modeling steps, the DEMO project and its “participatory modelers” are aiming to achieve at least some of the benefits of increased stakeholder participation described above. Compared to traditional use of model results in environmental decision-making, the experts’ role is transformed from a one-way communication of final results to assistance in various steps of a participatory process together with local stakeholders. Earlier research on public and stakeholder participation in environmental planning and management processes has shown that the degree of influence over the content and outcomes of the process is a crucial factor for deciding stakeholder commitment (Pahl-Wostl, 2002). Even though ambitions for real stakeholder influence may be high and sincere, process initiators may be unconsciously carrying out a top-down approach. To minimize the risk that our own process would be unreflectedly dominated by expert perspectives (i.e. scientific knowledge, academic agendas and priorities), and to make sure that the perspectives of local stakeholders were recognized, we felt a need for further problematizing the concept of “participatory modeling”.

Being a researcher, the involvement in a participatory modeling process raises a number of ethical and methodological issues. What are the advantages and disadvantages of giving various weights to expert and stakeholder perspectives? And, can we in our role as participatory modelers be sure that we are really inviting our research objects to an equal communicative relationship where local perspectives, knowledge and priorities are respected to the same extent as central and/or expert perspectives? In short, what do we mean by the term participatory modeling? We believe that to strike a fair balance between expert and stakeholder influence over the process, continuous reflection among ourselves and together with the involved stakeholders is vital. Whose descriptions of the eco-system and society are considered as legitimate, and whose issues are considered as important and therefore raised during the process? And, (how) could token participation be avoided in favor of shared expert and stakeholder decision-making power and a common ownership of the participatory modeling process?
Method: identifying key dimensions of stakeholder influence in participatory modeling

The DEMO project is not alone in its endeavor to combine the use of models with stakeholder participation in research about environmental management. To obtain a wider view of similar projects a Google Scholar-search of the words “participatory modeling” and “natural resource management” resulted in 34 hits published between 2000 and 2006. Most of the hits could be described as either work packages of various EU-financed research projects, applications of participatory modeling approaches by Western researchers in a developing context or other research projects concerning natural resource management (mainly in the US and Australia). Seven projects from the first and last groups were chosen for a scanning of project texts (i.e. project descriptions on the respective homepage of each project or responsible researcher and presented/published project papers) focusing on identifying generic dimensions or phases of participatory modeling processes. A number of key dimensions of stakeholder influence in participatory modeling were identified. The term “participatory modeling” was accompanied by concepts such as “agent-based modeling”, “mediated modeling”, “social multi-criteria evaluation”, and others.

The result of the scanning was then contrasted with systematized experiences (in the form of debriefings after each meeting) from the on-going DEMO project and with earlier water management projects focusing on stakeholder involvement in model-assisted discussions in Sweden: the VASTRA Catchment Dialogues (Alkan Olsson and Berg, 2005; Arheimer et al., 2005; Jonsson et al., 2005), CATCH (Collentine et al., 2005), the Genevadå Study (Wittgren et al., 2005), and the Svartå Project (Andersson et al., 2002). A one-day project workshop with five researchers (three modelers and two social scientists) was arranged to discuss the result of the scanning and earlier experiences. Altogether, experiences and documentation from 11 participatory modeling processes apart from the DEMO project were included in the analysis. Finally, six key dimensions of participatory modeling were agreed upon.

Arnstein’s (1969) critical discussion of different degrees of “real” decision-making power in urban planning processes was then taken as a point of departure to assess possible degrees of stakeholder influence over a participatory modeling process. The concept of participatory modeling in itself implies that stakeholders are “actively involved”, but throughout different phases of the process participants can be involved to different degrees, i.e. provided with information, consulted for their priorities or actively involved. It is assumed that the more weight given to stakeholder perspectives, knowledge and priorities, the higher the degree of influence they would have over the process. If, on the other hand, a process is dominated by expert perspectives, knowledge and priorities, stakeholders would have a lower degree of influence. No matter the balance struck between expert and stakeholder perspectives, an expert-initiated process always runs the risk of producing some manipulative tendencies where expert perspectives decide the direction, openly and consciously, or indirectly and unconsciously. To make the expert/stakeholder perspective scale functional it was filled with a number of examples of varying combinations of perspectives.

There are a number of methodological limitations to this approach. Firstly, the scanned projects are few and not selected on the basis of any strict scientific criteria to ensure representativity. They do represent a wide scope of project approaches, though, and together they are therefore assumed to cover the central dimensions of presently on-going participatory modeling initiatives. Moreover, they were all communicated in English and/or Swedish, and no other projects are included in the scanned material. This, of course, is a serious limitation as research fields and approaches communicated in other...
languages may be of high relevance. Secondly, the scanned project texts were of varying length, focus and the projects themselves in different states (yet to be initiated, on-going or finalized). Far from all of the six finally identified dimensions were covered by all of the projects/texts and this made it difficult to make a strict content analysis of the material. Instead the texts and experiences were used in an additive mode, aiming at synthesizing different experiences from different projects into an integrated whole.

Results and discussion
A number of factors have to be considered when designing and implementing a participatory modeling process. For example, the real decision-making power of the process, i.e. how well-embedded it is in political decision-making contexts at various scales, is crucial. The key dimensions of participatory modeling discussed here, are related to the degree of influence that experts and stakeholders have over various dimensions of the process. In each of the identified dimensions, expert and stakeholder perspectives, knowledge and priorities may influence the choices to be made in varying mixes. Depending on whose perspective has the larger influence, the process can be described as expert perspective or stakeholder perspective driven. The six dimensions of participatory modelling identified as the most important regarding the influence aspect include:
1. defining the issue of the process (WHAT?)
2. defining who should be considered as a stakeholder and thus be involved in the process (WHO?)
3. construction/choice of model(s) to be used in the process (HOW?)
4. setup of the model for the region covered by the process (HOW?)
5. use of the model throughout the process (HOW?)
6. process design (WHEN, WHERE and HOW?)
The six core dimensions, and the varying weight given to expert and stakeholder perspectives in each dimension, may be visualized as in Figure 1. Below, each of the dimensions and examples of varying combinations of expert and stakeholder perspectives will be discussed giving particular attention to dimensions 3, 4 and 5.

The issue of the process
The range of environmental issues that can be the focus of participatory modeling processes is quite wide and includes water quality and quantity management, natural...
reserve protection, air pollution, climate change and more. Often, the issue of the process, i.e. which natural resource management problem that the process will focus on, is decided beforehand by political, academic and research funding priorities. In such cases, various types of expert perspectives are dominating the choice of issue. In other cases, groups of local stakeholders themselves may identify an issue on the basis of their local knowledge and then incorporate experts and their perspectives into the process. The main deciding factor here, is probably the possibilities for financing of the participatory modeling process, as projects without focus are unlikely to be financed, and projects with a clear focus and a project budget, have little flexibility in changing the focus.

Who should be considered as a stakeholder

Depending on which environmental problem or natural resource management complex that is identified as the issue of the process, the most important stakeholders are to be defined. In this process expert and stakeholder perspectives can play different roles. It can be expert knowledge driven, structured by various academic tools for stakeholder identification and analysis or it can be driven by local knowledge, either by applying academic tools together with an initial groups of probable stakeholders, or by letting stakeholders structure their own identification process.

Construction/choice of model(s)

After deciding which stakeholders should be involved, a decision must be taken regarding which model(s) are to be used in the process. The choice of model will have far-reaching consequences for the scope of the participatory modeling process. Which parameters are to be included in the model, and thus an issue for discussion is crucial, as is the spatial and temporal scales that the model can handle.

At this point, there are a number of different scopes for the weight given to expert and stakeholder perspectives respectively. Sometimes, the participatory modeler of the process is in possession of an already existing model that is able to deal with the main aspects of the issue, and is eager to test this model in this setting. Another participatory modeler may have access to several models encompassing issue-relevant aspects, and may offer stakeholders a choice between these models. In such cases, decisions are to a large extent driven by expert knowledge, as there is often little or no opportunity for the stakeholders to influence the choice of model. Such cases would be placed in the left domain on the expert/stakeholder perspective scale (see Figure 1), but may be slightly moved to the right by making sure the structure and logic of the expert-chosen model is communicated to stakeholders. It can be even further moved to the right by also allowing stakeholders to suggest additional parameters to be included in the model. In some cases, important parameters suggested by the stakeholders may be overseen by the modelers, and including these may thus also improve the accuracy of the model itself. In this way local knowledge about the local ecosystem may be complementing expert descriptions in the form of numeric models. In other cases, local knowledge can be incorporated into the model in order to increase stakeholder trust, without improving the model as such. Thus, if local stakeholders are certain that the common visits by Canadian geese (destroying crops and producing noticeable amounts of manure) in the area have a large impact on nutrient transports, a routine for their probable contribution (i.e. grams of inorganic N and P produced per grown animal per day × the number of animals in the catchment and number of days they stay) may be added to the existing model. This routine may not give any significant effects on model results, and thus not improve the model per se, but it may be important as it is likely to improve the participatory modeling process in terms of trust, transparency and two-way communication.
At the right end of the expert/stakeholder perspective scale, we find cases where the participatory modeler has the ambition to construct a new model based on a combination of local and expert knowledge (see Figure 1). In such cases, the decision on which parameters are the most important in describing causal relationships around the identified issue, and consequently to be included in the model, is taken jointly by experts and stakeholders. The result is often a qualitative model that is sometimes complemented by numeric modules depending on local conditions and data availability. Somewhere in the middle, we find processes using both an already existing complex quantitative model and an intermediate model used solely for stakeholder communication purposes. In such cases, the numeric model may focus on some key relations of the issue, while the qualitative, intermediate model may be wider in scope.

Setup of the model

When the choice/construction of model has been made, it has to be set up for the region in focus for the process. For complex numeric models this involves quite a large amount of work including collection of data and calibration of the model by measured values. Stakeholders may have different degrees of influence over these activities. If all data is gathered from central databases without any validation from stakeholders, the process will give relatively more weight to expert knowledge than if stakeholders are invited to validate data sources and data, or even create sets of data themselves (see Figure 1). Examples of the latter may be soil mapping carried out at the farm level, specification of “typical management farms” and providing “soft data”, used for model parameterization, such as the occurrence of surface runoff and streambank erosion.

Another example where stakeholder perspectives are given considerable weight may be in monitoring campaigns where stakeholders are involved in monitoring of, e.g. water levels, secchi depths and water quality, i.e. “participatory monitoring”. The produced data is used for model calibration and validation. Participatory monitoring and inclusion of local knowledge in the setup of the model is likely to increase both the engagement in the process and the quality of the used data. (It may also result in strategic answers from stakeholders, though, which may reduce the accuracy of model results.) Regarding calibration of the model setup with stakeholder produced or validated measured data, the degree of influence of stakeholders may vary with the chosen model. The used model’s degree of specification of local variability of physical geographical factors, such as soil characteristics, lake depths etc., as well as of human impact, such as farm management practices and treatment of wastewater from rural households, determines the model’s sensitivity to stakeholder verification of local information used by the models. Also the model’s possibility to include more “soft data”, such as observation of surface runoff or flow through macro-pores, is a factor that need to be considered in assessments of stakeholders’ possibility to influence the model setup.

Use of the model

When the model has been set up, it could be used by identifying decision-situations where model results can be used to make better informed decisions. Model generated information can be presented in numerous ways depending on which aspects are to be highlighted (scale, distribution etc.). Here, expert and local perspectives can be given different weights in deciding which results are relevant. For example, by mapping the source apportionment for polluting substances, the model may assist in taking decisions about the distribution of costs for remedy implementation. Or, by showing the effects and costs for various remedies, the model may assist in taking decisions about a socially and economically sustainable cocktail of remedies. On the left-hand side of the expert/stakeholder perspective scale,
we find cases where management scenarios are entirely defined and developed by experts and presented to stakeholders as a discussion entry point (see Figure 1). Somewhere in the middle are cases where stakeholders, together with and via modelers/experts, are more involved in formulating the decision situations where model results are to be used. To the right of the scale we find a model interface that enables lay-users and stakeholders without model training to use the model without the assistance of a modeler (see Figure 1). With such an interface, local knowledge alone can drive decisions about how the model is used without any filter through an expert facilitator.

Process design
All former dimensions of participatory modeling and the possible balances between expert and local knowledge are subject to how the process is designed, e.g. where, when and how the arenas for collaborative learning emerge. Often, the participatory modelers have a key role in the practical organizing and structuring of the discussions. Whether experts or local stakeholders are responsible for this dimension, the where, when, and how questions can be solved in ways that give different weight to expert and local knowledge during the process. An arena for communication set out at a location and time less suitable to one type of involved actors will indirectly give more weight to the perspective of other actors. A discussion dominated by expert lectures (and therefore expert knowledge) can be contrasted to an interactive meeting where both local stakeholders (and local knowledge) and experts present and discuss their perspectives.

Conclusions
The paper has presented a structured approach for “participatory modelers” to assess how expert and local stakeholder perspectives could be balanced in six different dimensions of participatory modeling. The approach could be used before initiating a participatory modeling process for taking vital decisions about how the balance should be struck in a certain way (and why). When the process has started, the approach could be used as a tool for structured reflection over the methodological and ethical issues raised in the introduction. Participatory modelers and involved stakeholders together may use the tool to avoid unreflective tendencies towards expert knowledge dominance and a low degree of stakeholder influence. The approach may also work as a framework for analyzing the outcome of participatory modeling processes, such as the DEMO project.

Does giving more weight to stakeholder perspectives automatically result in more stakeholder influence? A general answer would be that, yes at least it would be easier to ensure stakeholder influence throughout the process, but there are also exceptions. For example, if a model interface is provided to give stakeholder perspectives more weight in the use of the model, the degree of influence of the stakeholders may also vary. The interface may be designed to carry out only a very limited set of exercises (to improve user-friendliness) or it may be more open in the functions that it can perform and thus be less limited by expert knowledge driven priorities.

Expert knowledge and perspectives are in many political and other decision-making contexts considered as more legitimate than local stakeholder perspectives. Thus, the final recommendations from a process giving higher weight to expert perspectives, for example, if based on results from a well-known numeric model, may prove more influential on central decision makers, than suggestions based on a qualitative model based on local knowledge. Giving higher weight to local stakeholder perspectives, on the other hand, will include different types of agendas than expert ones into the process of goal setting and priority making. In many cases local knowledge description of the causal relations within the eco-system may be “more correct”, or at least not more wrong than
the expert ones (Wilk, in preparation). Giving more weight to stakeholder perspectives is also likely to taking into account more of the complex situation of the local actors, including also aspects of social and economic sustainability, apart from the ecological sustainability that is often in focus within the expert perspective. Moreover, experts are in many contexts also stakeholders with their own agendas. No matter which assumptions are made regarding the objectivity of different types of knowledge, there is a risk that the agendas of powerful groups, whether experts or a particular stakeholder group, may “highjack” the process. As Flyvbjerg (1998:27) has pointed out: “power is knowledge” and “power defines what counts as knowledge and rationality and ultimately … what counts as reality”. Such risks are evident in all the six dimensions of participatory modelling.

As both the DEMO initiative and the accompanied process of reflection are still ongoing, the six dimensions identified here should not be considered as the ultimate ones. Moreover, to finalize the initial thoughts presented here, a more stringent analysis of other participatory modeling initiatives must be carried out, either by further analysis of published texts, or by interviewing selected participatory modelers, or both. Only then, could the results be considered as scientifically valid. Any suggestions are most welcome.

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