Bots, P. W. G., R. Bijlsma, Y. Von Korff, N. Van der Fluit, and H. Wolters. 2011. Supporting the constructive use of existing hydrological models in participatory settings: a set of "rules of the game." *Ecology and Society* **16**(2): 16. [online] URL: http://www.ecologyandsociety.org/vol16/iss2/art16/

Research, part of a Special Feature on Implementing Participatory Water Management: Recent Advances in Theory, Practice and Evaluation

Supporting the Constructive Use of Existing Hydrological Models in Participatory Settings: a Set of "Rules of the Game"

Pieter W. G. Bots [1,2], *Rianne Bijlsma* [3], *Yorck von Korff* [4], *Nicolien Van der Fluit* [5], *and Henk Wolters* [3]

ABSTRACT. When hydrological models are used in support of water management decisions, stakeholders often contest these models because they perceive certain aspects to be inadequately addressed. A strongly contested model may be abandoned completely, even when stakeholders could potentially agree on the validity of part of the information it can produce. The development of a new model is costly, and the results may be contested again. We consider how existing hydrological models can be used in a policy process so as to benefit from both hydrological knowledge and the perspectives and local knowledge of stakeholders. We define a code of conduct as a set of "rules of the game" that we base on a case study of developing a water management plan for a Natura 2000 site in the Netherlands. We propose general rules for agenda management and information sharing, and more specific rules for model use and option development. These rules structure the interactions among actors, help them to explicitly acknowledge uncertainties, and prevent expertise from being neglected or overlooked. We designed the rules to favor openness, protection of core stakeholder values, the use of relevant substantive knowledge, and the momentum of the process. We expect that these rules, although developed on the basis of a water-management issue, can also be applied to support the use of existing computer models in other policy domains. As rules will shape actions only when they are constantly affirmed by actors, we expect that the rules will become less useful in an "unruly" social environment where stakeholders constantly challenge the proceedings.

Key Words: *case study; conflict; hydrological model; institutions; Netherlands; participation; policy process; water management*

INTRODUCTION

Background

Article 14 of the European Water Framework Directive (WFD) requires stakeholder participation and the use of expert knowledge in water management decision processes (Eurpoean Union 2000). Although the benefits of stakeholder participation for a policy process are advocated on theoretical grounds in the literature (Fiorino 1990, Laird 1993, Webler 1995), with regard to empirical findings, Delli Carpini et al. (2004) note that: "Although the research...demonstrates numerous positive effects of deliberation it also suggests deliberation under less optimal circumstances can be ineffective at best or counterproductive at worst." The policy literature makes it clear that the use of expert knowledge may likewise be problematic. When scientific expertise is solicited by policy makers to legitimize decisions, it loses its authority in situations where: (1) science fails in predicting policy outcomes because of uncertain knowledge, (2) different scientists can be found to support different policies because competing theories means there is no single "truth" (Weingart 1999), and (3) stakeholders perceive aspects to be inadequately addressed (Hoppe 1999, van Buuren and Edelenbos 2004). Despite these difficulties, the policy literature also makes it clear that participatory processes are essential for linking science and policy (de Bruijn and ten Heuvelhof 1999, Munnichs 2004).

Therefore, implementing the WFD poses a substantial challenge for water managers. Water systems are physically complex, and expert

[1]Delft University of Technology, [2]Cemagref, [3]Deltares, [4]Lisode, [5]Buro Natuur+Water

knowledge, in large part embodied in computer models, is often partial and rife with uncertainties (Walters 1997). Moreover, water systems are intricately linked to virtually all types of human activity. This means that water-related decision processes must deal with competing values, preferences, and perspectives of many different stakeholders (Blomquist and Schlager 2005, Blackmore et al. 2007). As water is a vital resource, the stakes are high. Meanwhile, knowledge about the socioeconomic system is distributed over different scientific disciplines, as well as locally over the actors concerned by a specific water-related issue. Consequently, the available knowledge, both physical and socioeconomic, is often contested by stakeholders (van Latesteijn 1998, Fischer 2003).

Focus

Here, we focus in particular on the role of knowledge about physical water systems that is embodied in hydrological computer models. Van Daalen et al. (2002) show that in environmental policy development, computer models can play different roles: they can serve as: (1) eye-openers, by drawing attention to a specific issue, (2) arguments in dissent, by advocating a particular world view, (3) vehicles in creating consensus, by accommodating alternative perspectives, and (4) management tools, by assessing the effects of policy measures. The hydrological models that we observed in our case study served in the fourth of these roles.

Although hydrological models represent only a limited range of aspects of the physical world, nevertheless, they tend to be “black boxes” in the sense that decision makers and stakeholders cannot easily verify whether the predictions these models make are realistic. They have to largely rely on the competence of the modelers to produce reliable images of future states of the world. This makes “trust” in models a key factor in policy processes (Shackley 1997, Saunders-Newton and Scott 2001). Lack of such trust can hamper the process. When the validity of a model is contested, it may be discarded in its entirety, even when stakeholders could potentially agree on the validity of part of the information that it produces. This information is then lost to the process. Developing new models as proof against the objections made is costly in time and resources, and even when these are available (which is often not the case), the results obtained with the improved model may eventually be contested again.

One strategy to avoid such stalemates is to involve decision makers and stakeholders in the process of model development with an aim to increasing trust by making the “black box” transparent (Pahl-Wostl 2002, van Eeten et al. 2002, Barreteau 2003, Etienne et al. 2003, Jackson 2006, Pahl-Wostl 2006, Howick et al. 2007, Bots and van Daalen 2008). When guidelines are provided (Smith Korfmacher 2001, Caminiti 2004, Karas 2004, Voinov and Brown Gaddis 2008), these typically set objectives (e.g., the modeling process should be transparent, the public should participate continuously and have influence on modeling decisions) and suggest tactics (e.g., make modelers document and present their assumptions and the model’s uncertainties and limitations, manage the expectations of stakeholders from the start). However, they do not make clear how these objectives can be attained or how these tactics can be implemented procedurally.

A second strategy is to determine, in interaction with decision makers and stakeholders, for what purposes the model could still be used. This strategy differs from the first in that the objective is not to develop a model that meets the information need for a given decision scope for all parties, but to develop the parties’ understanding of the capabilities and limitations of a given model and adapt the decision scope to these. This strategy will require fewer resources, but it may resolve only part of the issue, and/or still require new model development. The decision context will guide which strategy is preferred.

The second strategy was adopted in the case we studied. To our knowledge, this strategy has not received attention in the literature. Therefore, the question we focus on here is how existing hydrological models can be used effectively in a multistakeholder setting, even when their validity is questioned. Ehrmann and Stinson (1999) emphasize that processes to deal with policy situations in which the level of trust among parties is low must be firmly embedded in the larger policy decision-making process by defining a set of “ground rules.” Taking this to heart, our aim is to define “rules of the game” that set a standard for actors in particular roles in the process as to “how to behave,” insofar as existing hydrological models are concerned.

Case Study

The set of rules that we propose is inspired by a participatory process that took place in The Netherlands. It concerns the water management issue of defining a so-called "desired groundwater and surface water regime" (Gewenst Grond- en Oppervlaktewater Regime [GGOR]) for the Bargerveen, a nature-conservation area in the province of Drenthe in the northeast of the Netherlands. The Bargerveen has been given Natura 2000 status, and the Dutch national government mandated that a GGOR be formulated for all Natura 2000 areas by the end of 2007, as part of a full-fledged Natura 2000 management plan that was to be developed by the province before 2010. The intention of the Bargerveen GGOR was to strike a balance among competing water interests in the Bargerveen and its surrounding area, which is primarily agricultural land.

The local Dutch water authorities, or "water boards," and the national authorities responsible for rural development have agreed on a general procedure for determining a GGOR for a particular geographical area (Gehrels 2003, Nationaal Bestuursakkoord Water 2003, Vlotman and Jansen 2003). This procedure first establishes reference water regimes: (1) the "actual" regime that is currently in practice (AGOR), and (2) a theoretical "optimal" water regime (OGOR) for each land-use function in the area, that is, agriculture, housing, industry, or nature, for example. To determine what is "optimal," the relation between the groundwater regime, soil type, and "land-use performance" has been established for a broad range of functions (Gehrels et al. 2003). The performance indicator is a percentage, where 0% indicates the worst case, for example, maximum crop loss because of drought or local disappearance of a species, and 100% indicates the best case, for example, optimal crop yield or optimal ecological conditions. This indicator has been calculated for the most important crop types and nature types for the full range of soil type–groundwater regime combinations using best available knowledge.

Once AGOR and OGORs are known, alternative water regimes are defined and assessed in an iterative process until a regime is found that realizes a certain percentage (typically >70%) of the optimal performance. If this criterion cannot be satisfied for the present land-use functions using the available means for operational water management, changing land use, and/or taking more radical hydrological measures, may be considered. The GGOR procedure presupposes the use of hydrological models for ex-ante assessment of such measures.

In line with the WFD, the Dutch national administrative water agreement requires a GGOR to be developed in close cooperation with stakeholders (Nationaal Bestuursakkoord Water 2003, Article 5). The water board ("Velt en Vecht"), being the responsible authority for the formulation of Bargerveen GGOR, wanted to achieve a broadly supported GGOR, to avoid rejection in the upcoming provincial planning process. The water board opted for an approach that reflects what Laird (1993) calls "pluralism," as opposed to "direct participation," as it involves a "sounding-board group" whose members have been selected such that all stakeholder positions are represented. The water board employed the fourth author of this article, a private consultant with experience in participatory decision-making processes on regional water management issues, to lead the process, supported by a team of employees of the water board and an external hydrological-modeling consultant. The water board invited the other authors of this article to take part in the stakeholder participation process design, implementation, and evaluation.

Outline

The "rules of the game" that we focus on were not defined ex ante and then "imposed" on the GGOR process but, rather, they were elicited ex post. Our research aim was to make explicit the "rules of the game" that, from our perspective, have implicitly been steering the cooperative behavior of participants in the GGOR process that we were involved in as researchers and practitioners. We present the conceptual model that we used as the basis for formulating "rules of the game," followed by the "rules" that we derived, and demonstrate where we observed them as "rules in action" in the GGOR process. Finally, we reflect on local conditions that may influence the efficacy of the proposed code of conduct.

METHODS

The work we present here is what Schön (1983) calls "reflection on action." Intrigued by the particular way in which existing hydrological models were challenged but nevertheless used in the Bargerveen GGOR process, we decided to analyze this process by looking at the underlying institutions (North 1990, Ostrom 1990, 1999). The GGOR procedure is embedded in legislation and, therefore, is what North (1990) calls a "formal" institution. It provides a rational framework for decision making. The participatory implementation of the GGOR procedure by the water board (Velt en Vecht) builds on "informal" institutions, that is, conventions and norms of behavior. Our aim was to elicit these as procedural rules that describe what actions are considered appropriate for, and expected from, participants. Our "rules of the game" should specifically address the use of computational models and, preferably, afford generalization beyond the GGOR context.

The term "rules of the game" encompasses several aspects. Rules are social constructs that shape social action, while at the same time they are reaffirmed through being used by social actors (Giddens 1984, Ostrom et al. 1984, North 1990). Rules will continuously be interpreted and contested by actors, because they constrain them. Social interaction "about" rules will typically be structured by additional rules. The general GGOR procedure, for example, was enacted following a well-established formal legislative procedure. In contrast, the GGOR itself provided no clear rules for its implementation in a participatory way. We investigated how this "institutional void" (Hajer 2003) was filled, focusing on the rules; we did not examine the mechanisms by which these rules were adopted, such as policy learning (Grin and Loeber 2006), or negotiation (Fiorino 1990).

We articulated the rules following the process; they were not used overtly, in the sense of being made explicit to participants, to design the process. However, many of the ideas that we now articulate as rules were brought to the fore by the authors during project team meetings in which the next steps for the process were discussed, such as holding sounding-board group meetings and other interactions with stakeholder groups, experts, or modelers.

Crawford and Ostrom (1995) provide a general syntax for rules. This syntax is represented by the acronym ADICO, where *A*=attributes that identify specific participants to which the rule applies, *D*= the deontic operator that specifies whether the rule permits, forbids, or obliges participants to take some action, *I*=aim, that is, the particular action or outcome to which the rule refers, *C*=conditions that specify when, where, and how the rule applies, and *O*="or else," the part of the rule that specifies the consequences for a participant who does not comply with the rule. As an example, we parse a "rule of the game" for a joint fact-finding process proposed by Ehrman and Stinson (1999) according to the ADICO syntax: "Participants in a joint fact-finding process (*A*) must not (*D*) distribute any information they receive (*I*) until the group as a whole agrees on the timing and method of its distribution (*C*)." This example shows that not all parts need to be present. An "or-else" part could look like this example: when a participant has information that pertains to the policy decision (*C*), this participant (*A*) must (*D*) share this information with other participants (*I*), or else this information may be ignored by the decision makers (*O*).

We use the ADICO model to denote our "rules of the game." The *A*-part of these rules is either "all participants", i.e., the set of actors who take an active part in the policy process, or one of the five subsets of participants that we define below by describing their characteristic role attributes:

- Stakeholders: actors whose interests may be affected by the policy decisions that will result from the policy process that is being investigated;
- Decision makers: actors with the authority to make these policy decisions;
- Modelers: actors who have the technical competence to develop and operate computational models;
- Experts: actors whose knowledge on a particular topic is acknowledged by all participants;
- Process manager: the actor responsible for managing the policy process by planning and facilitating the interaction among participants; and
- Process sponsor: the actor who has commissioned the management of the policy process to the process manager and who can decide on the resources that are allocated for this process; this role is also referred to as "lead agency" (Beierle and Konisky 2000, Ryan 2001).

These actor roles need not be mutually exclusive. Modelers, for example, usually also are, or become, experts; stakeholders may also be experts on particular aspects of the social–ecological system ("local knowledge"); experts may also be stakeholders, for example, ecologists who champion a particular species; and process sponsors are often also are decision makers. Moreover, the term "actor" may refer to multiple people so, despite their singular form, the roles of process sponsor and process manager may be assumed by several individuals.

In the "rules of the game," we distinguish the following entities:

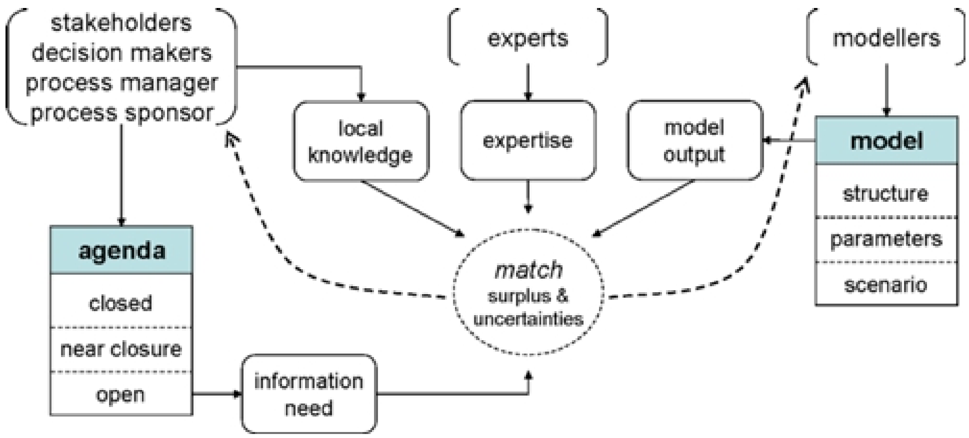
- Social–ecological system: the part of the real world that is the object of the policy process for which the "rules of the game" are defined;
- Measure: a course of action that is expected to produce desirable changes in the state of the social–ecological system;
- Option: a particular course of action that may be implemented;
- Decision: a choice from among several alternative options; a decision may be substantive, i.e., part of the policy, for example, on what measures to take, or on budget limits; as well as procedural, i.e., on the way to proceed in the policy process, for example, on what model to use, or on whom to invite, and what to discuss during the next meeting;
- Agenda: an overview that shows all decisions that are relevant for the policy process and specifies for each decision whether it is still "open," that is, where no choice has been made among alternative options and new options can still be proposed, "near closure," that is, no choice has been made but sufficient information on options and consequences is available to make a choice, or "closed," that is, the choice for a particular option has been made;
- Model: a representation of the social–ecological system that can predict, with some degree of accuracy, the consequences of implementing a particular measure; the set of variables and their computational relationships constitute the "structure" of the model. We distinguish between "input variables," i.e., variables with assigned values ("inputs") to represent measures (e.g., digging ditches) and exogenous factors (e.g., precipitation levels), "parameters," i.e., variables whose constant values represent invariable system characteristics (e.g., the geometry and hydraulic conductivity of soil layers), and "output variables," i.e., variables whose values ("outputs") are computed when the model is executed, and of interest to participants (e.g., minimum, maximum, and average groundwater levels); and
- Scenario: a set of inputs that when the model is executed is expected to produce outputs that predict the effects of a measure as accurately as possible, given the model's structure and parameters.

Figure 1 highlights some of the assumptions we make with regard to the relative position of some of these actor roles and entities:

- The agenda is determined by stakeholders, decision makers, the process manager, and process sponsor. The open decisions on the agenda correspond to an information need.
- These same actors can provide local knowledge, whereas experts provide expertise. The distinction between these two types of knowledge hinges on the recognition of the source as an expert.
- Modelers develop the model by modifying its structure and/or parameters, and "translate" proposed measures into scenarios.
- Local knowledge, expertise, and model output are expected to satisfy the information need to some extent, that is, the "match" between supply and demand of information. The term "surplus" refers to information that is considered irrelevant to the decisions on the agenda, whereas information that is lacking is denoted as "uncertainties." Uncertainties inform agenda setting and model development.

The diagram in Fig. 1 does not identify actions and, thus, does not reflect the dynamics of the policy

Fig. 1. Elements of a model-informed participatory policy process.



process. The implicit assumption is that the actors will affect the agenda either directly by their actions, or indirectly by provoking actions of other actors. If we make the assumption that all actions are governed by (implicit) rules, then the set of rules we define should be a "closed system" that covers all process activities in such a way that actions triggered by one rule produce changes that trigger new rules, or the process terminates.

To assess whether the set of rules as a whole can produce the type of participatory process that we observed, we chose the framework proposed by de Bruijn et al. (2002). The four core elements of this framework are compatible with the general criteria of fairness and competence put forward by Webler (1995), but also make explicit the time aspect of a participatory process:

1. Openness: the process is open in terms of participation, that is, all stakeholders have access to the process; problem definition, for example, broad in scope, and flexible; and solution space, that is, there are no pre-set restrictions as to what constitutes a good solution.

2. Protection of core values: the process does not lead participants to act against their own interests.

3. Substance: the process makes use of relevant substantive knowledge, drawing on the capacity within the stakeholder network to generate variety as well as to make selections.

4. Speed: the process gains and maintains sufficient momentum to achieve significant results in the end.

Obviously, tensions exist among these elements. For example, if (new) stakeholders bring up new considerations, the process may not come to a conclusion; that is, there is a trade-off between openness and speed. If decisions are based on a particular model, some stakeholders may opt out for fear of it producing unfavorable results for them; there is a tension between substance and protection of core values. Therefore, when we defined our "rules of the game," we checked whether they would allow the process manager to strike a balance among all four elements.

Our post-hoc rule definition process was essentially heuristic. Using the elements in Fig. 1, the first author drew up a "skeleton set" of rules that, when "executed," would produce a very general "fair and competent process" (Webler 1995). He then gradually extended this set, aiming to cover as much as possible of the activities and decisions observed in the Bargerveen GGOR process as rules that specify what is "proper behavior" for participants in this process. In this way, the deontic operator, *D* in the ADICO syntax, always obliged participant *A* to do *I*, given condition *C*. The "or-else" part *O* of the rules was left implicit, as no concrete sanctions on rule breaking were observed. The rule set was then critiqued by the second author, modified, and reviewed again. The set was then validated by the other authors, notably the manager of the GGOR process herself. Finally, to check relevance and completeness, the second author used the rule set as a coding scheme to label the occurrence of "rules in action" found in the condensed process description.

RESULTS

We present the results of our analysis as four sets of rules:

1. Agenda-management rules (AM) that regulate the decision making process;
2. Information-transparency rules (IT) that regulate the development of a shared information set;
3. Model-transparency rules (MT) that regulate the communication about models and model output; and
4. Measure-proposal rules (MP) that regulate how participants can put forward measures to resolve the policy issue

The first two sets apply to the overall process. They provide the context for the other two sets, which specifically address the use of models to assess policy measures. We did not examine the rules that guided the selection of participants, but the general principle was that all relevant stakeholders should be represented. Being very familiar with the Bargerveen area and the interests at stake, the process sponsor and process manager drew up an initial list of delegates. During its first meeting, this "sounding-board group" (see Appendix 1) worked on identifying interests and stakeholders that were not yet represented, and people who should be included.

We denote the rules using a syntax that is based on ADICO but allows some "shorthand." The attribute-part *A* of a rule will always be one of the participant roles. We can leave the deontic operator *D* implicit, because all of our rules define appropriate behavior. This means that all verb phrases denote aims (*I*). When the condition-part *C* is omitted, this should be read as "at all times." Such rules expect constant vigilance from the participants it concerns. When rules logically fall in sequence because one rule creates the condition for another, we present these rules together to further improve legibility.

Agenda-Management Rules

- AM-1: The process manager prioritizes the decisions on the agenda, explains why the decisions need to be made and why in that particular order, to progress towards the final policy decision, and determines which actors are "decision makers" for which decision.
- AM-2: For each decision on the agenda, the stakeholders indicate "near closure," that is, when they find the available information sufficiently complete and reliable for making the decision, or they indicate what uncertainties exist that prevent closure.
- AM-3: When a decision on the agenda is "near closure," the associated decision makers choose an option and explicate their deliberation while referencing the available information. The process manager then marks these decisions as "closed."
- AM-4: When uncertainties prohibit progress, that is, no high priority decisions are "near closure," the process manager consults with the process sponsor on the availability of resources, and with the modelers and experts on possible additional analysis. The process manager then develops alternative options for dealing with the uncertainties, and places this procedural decision on the agenda.

Rule AM-1 constitutes the process manager as the "procedure maker." It is a crucial rule: if the process manager fails to establish and maintain a legitimate agenda, all other rules fail automatically. The rule states that the process manager "determines," rather than "decides," who is decision maker for which decision. Thus, if the choice of decision maker becomes an issue, it can be put on the agenda as a procedural decision for which the process manager can propose decision makers.

The agenda management rules mainly favor speed, but rule AM-2 allows stakeholders to protect their interests. Rule AM-4 ensures that the process cannot "block," allowing the process manager to diagnose the lack of decisiveness and frame the problem as a procedural decision. The alternative options for this decision will be either to “accept uncertainty,” that is, the decision makers take their responsibility and accept the risk that may be involved, “reduce uncertainty, ” that is, the decision makers seek additional information, or “reduce decision scope,” that is, the decision makers look for alternative decision options that pose less uncertainty. Rules AM-1 and AM-2 ensure that the information that is needed to make this procedural decision will be sought before a choice is made. The obvious catch is that it may be difficult to identify a legitimate decision maker for this procedural decision. It is typically at this point that the process manager will have to choose a trade-off between the four core elements, and powerful actors such as the process sponsor or decision makers are likely to exert their influence.

Information-Transparency Rules

- IT-1: The participants communicate what information they consider to be relevant, specifying the decision(s) that should be based on this information.
- IT-2: The participants report when they obtain new information that may be relevant for decision making.
- IT-3: The process manager maintains and shares with all participants an overview of the information that has been identified as relevant and/or available.
- IT-4: The participants note the information that is available and notify the process manager of information that appears to be contradictory or missing. The process manager notes these instances as uncertainties in the overview.
- IT-5: The participants identify people they consider to be knowledgeable on a subject where uncertainty has been identified. The process manager verifies with these people to see whether they can indeed contribute relevant information. If so, these people are invited to participate in the process as experts.
- IT-6: If different experts are proposed for the same subject, these experts determine whether their views conflict. If so, the experts clarify their differences of opinion. These differences are noted as uncertainties.

The decisions referred to by these rules may be substantive as well as procedural. Likewise, the information may be substantive as well as “meta-information,” for example, information on where other information can be found, or information on the quality of other information. The information-transparency rules mainly favor openness and substance, but rules IT-1, IT-5 and IT-6 also allow stakeholders to protect their interests. Rule IT-5 is an “entry rule” in the sense that it allows new actors to become participants. With rule IT-2, individuals who accept the invitation to participate as an expert on a subject share their knowledge on this subject with all participants.

Model-Transparency Rules

- MT-1: The stakeholders explain which phenomena in the social–ecological system are of particular interest to them in such a way that the modelers can assess whether, or to what degree of accuracy, these phenomena can be predicted by the model.
- MT-2: The modelers explain the structure and parameters of the model, as well as the scenarios that are evaluated, in such a way that the stakeholders can assess which phenomena in the system are represented in what detail, and what this means for the uncertainties in the model output.
- MT-3: The process manager maintains and shares an overview of the aspects that are known to be (not) represented by the model and clearly relates this to the information that has been identified (by rule IT-1) as relevant for some decision(s) on the agenda.
- MT-4: When there are alternative models or alternative ways of representing an aspect in the model, the modelers communicate to the process manager, the options and their consequences in terms of what the model can and cannot do. The process manager then adds the choice from among these alternatives to the agenda as a procedural decision.
- The model-transparency rules follow the same principles as the information-

transparency rules, but expand these by making explicit the joint responsibility of modelers and stakeholders to make "black-box" models more transparent.

Measure-Proposal Rules

- MP-1: The participants propose a measure first as a generic option, i.e., as a class of possible options, leaving design parameters and implementation details unspecified.
- MP-2: When the effects of a generic option have been noted as uncertain, the modelers calculate these effects using different scenarios to reveal the range of impacts of this class of options.
- MP-3: The process manager communicates the results of this impact assessment with all participants. The stakeholders then express their opinion with regard to the option's desirability and feasibility. With rule IT-2 and IT-3, the impact assessment results, together with the stakeholder opinion, are added to the information set.
- MP-4: During formal meetings, participants refrain from discussing options for which the impacts are still being assessed.

The measure-proposal rules mainly favor openness, substance, and speed. From rule AM-2 (in combination with rule IT-2), it follows that participants can propose a new policy measure at any time in the process. Rule MP-2 mitigates the risk of losing time and resources on model exercises that are unlikely to produce relevant new information, whereas rule MP-4 aims to avoid losing time on premature discussions. The interaction between measure-proposal rules and information-transparency rules ensure the protection of core values (IT-4 provides guidance in the event that actors disagree on the option's effects). The agenda-management rules provide guidance in the event that the impact assessment requires additional model development. Likewise, they guide the process of developing generic measures into more specific measures because actors will not indicate "near closure" until information on the impacts of sufficiently detailed option variants is available.

The Bargerveen Case Study

The four sets of rules are the result of our reflection on the Bargerveen GGOR process, in which we were involved as researchers and practitioners. Here, we discuss the water management issue in question, as well as the stakeholders.

The Bargerveen area is situated in the east of the Netherlands at the border with Germany, in the Dutch province of Drenthe. It has recently received Natura 2000 status, which makes it a priority nature-conservation area. The Dutch ministry for Agriculture, Nature and Food Quality (Landbouw, Natuurbeheer en Voedselkwaliteit [LNV]) has formulated nature-development objectives for the area (LNV 2006, 2007), which is home a type of living high peat that is unique in Europe. The main objective is to increase the total area of high peat, which is currently declining. This requires the groundwater level to be raised, which will affect the water regime in the surrounding area.

The stakeholders in the area share a long history of negotiation over the water regime; they are collectively well organized. The last attempt to settle the water-regime conflict in 2001 resulted in an agreement for the north and west side of the Bargerveen, but failed for the south side. The German side (east) was not included. The Natura 2000 status of the Bargerveen re-opened the negotiations. The water board decided to restrict these negotiations to the south and east side, leaving the existing agreements undisputed.

Key actors for these new negotiations—the GGOR process— are: the water board, the national nature-conservation agency responsible for operational management of the Bargerveen (Staatsbosbeheer [SBB]) and the farmers whose lands will be affected by a change in water regime. These farmers are organized in a local chapter of the national agriculture and horticulture organization. The farms are mostly family businesses and the land is alternately used for intensive crop growing and dairy farming. The current water regime is already quite "wet" for this land use. The water-regime conflict brings about uncertainty for farm management, and the farmers are calling for clarity and action. They are apprehensive about getting involved in yet another indecisive negotiation process. Additional stakeholders are the local residents, entrepreneurs, neighboring municipalities, and the German local water authorities. The GGOR is to be approved by the board of directors of the water board, then by the province of Drenthe, and ultimately by the ministry of LNV. All interests are represented in the sounding-board group (see Appendix 1).

Rules in Action: The Bargerveen Process, Focusing on Hydrological Models and Expertise

The GGOR project team, including the process manager, modelers, and support staff, started the GGOR process in June 2006. We distinguish four phases in our description of the process. The first phase was the preparation phase, ending with the installation of the sounding-board group in October 2006. The second phase, which lasted until April 2007, was focused on the development of a shared knowledge base. In this phase, the participants agreed on the reference water regimes AGOR (actual water regime) and OGOR (optimal water regime) for the primary interests of agriculture and nature conservation. The rest of the process, directed at defining GGOR, can roughly be divided in two phases: the selection of a model and identification of possible measures, which lasted up to November 2007, and the assessment of these measures and definition of a GGOR, which took until April 2008.

During the preparation phase, the project team performed a stakeholder analysis (Bryson 2004) and developed a "plan of approach" for defining the GGOR for the Bargerveen. The process manager presented this plan at the first sounding-board group meeting (IT-3). She urged participants to comment on the plan and on the composition of the sounding-board group, and to share other information that they considered relevant (IT-2). The farmers observed that the plan did not include defining an OGOR for the surrounding agricultural land, and stressed the relevance of knowing the current deviation from the optimal water regime to realistically judge the consequences of new measures for agriculture (IT-1). The process manager proposed to let the project sponsor decide on this (AM-1), and the water board agreed to include the task in the plan (AM-3).

To develop a complete information base and determine the reference water regimes for nature conservation and agriculture, the process manager organized bilateral meetings. The OGOR for an area depends on the land use. The project team suggested basing the land use in the agricultural area on satellite data from 2003 (IT-3). The farmers did not agree to this (IT-4), arguing that the land use varies each year and that the satellite data provided a random snapshot. They proposed basing the agriculture OGOR on the form of land use requiring the lowest water level (IT-1). This appeared to be a strategic move. When the water-board professionals judged the optimal water regime as being too dry for agricultural purposes, the farmers remained noncommittal. In a second meeting, they explained that local water buffering is possible, but that there are no means for coping with "wet" regimes. The project team accepted this argument (AM-1) and decided to follow the farmers' proposal (AM-3).

The definition of the nature-conservation OGOR was hindered by many uncertainties (IT-4). The Natura 2000 objectives did not specify where in the Bargerveen high peat growth should be realized, and the optimal conditions for high peat development were not determined (IT-4). The process manager consulted a team of experts identified by SBB (IT-5). Despite differences of opinion, this team agreed on a best available expert opinion for the OGOR for nature conservation (IT-6). They stressed that high peat is very particular and needs near optimal conditions to develop.

At the second sounding-board meeting in April 2007, the process manager first shared the results of the bilateral meetings with the farmers and SBB (IT-3). The optimal regimes for nature conservation and agriculture differed widely: the OGOR for nature conservation entailed an expected highest groundwater level (in winter and spring) for the agricultural area that was several meters above the 1.2 m below-ground surface that was considered optimal by the farmers. Neither OGOR came close to the water regime currently in practice (AGOR). The process manager opened the discussion by pointing out that the Bargerveen's natural processes would only benefit from a drastic change in water regime—too drastic for the water board to decide upon, because the options were either to do nothing and accept a degradation of the peat vegetation, or to create a hydrological buffer zone around the Bargerveen at the expense of agricultural activities. The process manager proposed to leave this decision to the province and LNV (AM-1), as these organizations are vested with the capacity to either change the nature-conservation objectives, or authorize a change in land use and finance a buffer zone. The participants did not agree with this strategy, arguing that the available information did not warrant such a step (AM-2). The farmers feared that decisions would be made with insufficient consideration of their interests. Staatsbosbeheer wanted more information about the effects of the proposed measures, and there was no consensus about the effects of a buffer zone (IT-1).

At the conclusion of this sounding-board group meeting, there was a call for additional analysis (AM-4). The executive board of the water board did not want to embark on a costly model exercise. They felt that sufficient information was available from past studies, and aimed for a fundamentally political decision to be made by the province and LNV. Nor were the farmers interested in another model study; they just wanted clarity about continuing to farm. However, Staatsbosbeheer, was keen on having accurate model calculations, as they feared ending up with a buffer zone that would not produce the conditions needed for high peat growth.

The available models were MIPWA (Berendrecht et al. 2007) and Microfem (Hemker et al. 2004). The modelers recommended using MIPWA to explore the effects of proposed measures. This model was especially designed to support GGOR processes in the northern part of the Netherlands, and was co-financed by the water board. The Microfem model, tailored for the Bargerveen area but for a different type of calculation, was considered inadequate (MT-4). The project team started to prepare MIPWA for calculations—without explicit approval of the project sponsor—to produce quick results and demonstrate the benefit of the calculations to the project sponsor and participants. However, the modelers soon identified serious shortcomings with the model. It emerged that model enhancement would take at least a year.

At this time, the project sponsor stalled the process for strategic and financial reasons, thereby seizing the role of process manager in AM-1. Before allocating money for model enhancement and calculations, the water board wanted to know whether the province would be willing to support and finance a buffer zone at all. The water board principal contacted the provincial executive in October 2007. The provincial executive requested information about the effectiveness of a buffer zone that would warrant the significant costs of this type of measure (IT-1). Sensitive to the argument that time and resources for obtaining detailed information were lacking, the provincial executive accepted to base her decision on the best possible prediction with the available models (MT-1). As MIPWA's shortcomings precluded calculations of any accuracy, the hydrologists re-evaluated the Microfem model and concluded that the model could give a rough indication of the effectiveness of a buffer zone (MT-4). The executive board of the water board decided to finance the application of this model (AM-3).

This decision induced a series of model-related activities and decisions. The process manager and modelers discussed with the stakeholders how best to develop information for the provincial executive. The process manager decided to evaluate the effects of a buffer zone of various types and sizes (MP-1). She argued that information about the possible range of impacts of the buffer zone would give more direction to the discussion about its feasibility and desirability (MP-2).The stakeholders found it odd to spend resources on the exploration of a measure without first discussing the feasibility and desirability of the implementation details, but nonetheless went along with the plan (MP-4).

The process manager organized meetings with each of the key stakeholders and the provincial representative of the sounding-board group to discuss the intermediate model results (MP-3). During these meetings, the modelers explained the structure and parameters of the model, as well as the scenarios evaluated. They presented the model outputs visually with maps that showed the predicted groundwater level related to the two OGORs (MT-2). During these meetings, the process manager stressed the limitations of the model and urged the participants to make clear what, in their opinion, could be decided on the basis of the Microfem model (MT-3). Staatsbosbeheer initially opposed using the rough Microfem model. They critically assessed the model and the scenarios evaluated, and proposed some changes, but finally agreed on its use to determine the order of magnitude of the effects of a buffer zone. The farmers proposed additional scenarios to evaluate the effects of the OGOR for agriculture on the Bargerveen, to which the process manager agreed. Furthermore, they communicated that they were not only interested in water levels, but also in the drainage possibilities for wet parcels (MT-1). Both SBB and the farmers insisted that the process manager should explain to the province not only the calculated effects but, also, the opinions that they, as stakeholders, had given on these effects (MP-3).

The farmers also proposed evaluating an alternative option: putting an impervious screen in the subsoil between the Bargerveen and the agricultural land (MP-1). The hydrologists explained that the effectiveness of this measure could hardly be evaluated ex ante. Such a screen must be placed upon a completely impervious boulder clay layer. Complete knowledge of the boulder clay layer is impossible to obtain, which implies a high risk that this measure might be ineffective. However, the farmers had found an expert with a different opinion (IT-4, IT-5). The process manager asked the experts to discuss their difference in opinion, and in the end they agreed that the effectiveness of an impervious screen was very uncertain (IT-6).

The Microfem model calculations predicted that a buffer zone at the south side of the Bargerveen at least 500 m wide would be reasonably effective. Based on this information, in February 2008, the province gave the green light for negotiations about a buffer zone (AM-3). A final sounding-board group meeting was called in April 2008 to agree on a GGOR "in principle." This GGOR, in principle because funding was not yet firm, comprised a 500–m wide buffer zone along two-thirds of the south border of the Bargerveen plus measures to compensate the other interests. Before the meeting, the director of SBB had personally given his approval for this GGOR, and both the province and LNV had committed to finding the financial resources.

During the meeting, the farmers restated their willingness to consolidate and sell land in return for complete financial compensation and near-optimal circumstances for the remaining agricultural land (MP-3). The participants were about to state "near closure" (AM-2) for the GGOR on the condition that funding would be found, but then an influential expert from SBB voiced that the organization still had objections to the GGOR that would be put forward after the meeting (MP-3). The farmers instantly flew into a rage and voiced their distrust of SBB; in the previous negotiation round of 2001, SBB had made a similar move, rejecting an agreement at the last moment. The process manager reacted firmly, recalling the approval of the director of SBB, and emphasizing that the expert was to share any new information or considerations during the meeting, and not afterward (IT-2). It appeared that, possibly because of poor internal communication within SBB, the expert was still looking for negotiation space. The SBB manager present at the meeting hurried to confirm that SBB agreed to the GGOR, and no new information was brought forward.

The water board, LNV, the province of Drenthe, and SBB signed a formal agreement on the GGOR–in–principle (still pending funding) for the Bargerveen and its surrounding area in October 2008. Subsequently, the GGOR was formally approved by the provincial council and, in May 2009, the complete plan, with a total budget of €20 million, was ratified by the general board of Veld en Vecht. As a first step in its implementation, a detailed water management plan is presently elaborated for the agricultural area south of the Bargerveen.

DISCUSSION

Having presented the "rules of the game" for a model-informed participatory policy process, and having shown how we observed these rules "in action" in the Bargerveen GGOR process, we will address the following questions:

- What's new, or, more specifically, how do our "rules of the games" differ from guidelines and rules that have been reported previously on this topic?
- What factors ensure that these rules will effectively steer participant behavior?
- Related to the previous question, will these rules work in other contexts?
- What is the contribution of this research to the management of water resources and associated social–ecological systems?

Comparison with other Guidelines and Rules

Guidelines for model development and use in policy processes (Smith Korfmacher 2001, Caminiti 2004, Karas 2004, Voinov and Brown Gaddis 2008) emphasize good and continuous communication between modelers and other participants about what the model should preferably be able to do, from the participants' perspectives, and what it actually can do, from the modelers' perspectives. Our "rules of the game" that relate specifically to the use of models (the sets MT and MP) do not go far beyond this norm. However, guidelines per se are difficult to put into practice. What we see as a distinctive feature of our model-transparency rules and measure-proposal rules is that they become meaningful and practical because they are imbedded in other, more general, rules for agenda management and information transparency. Thus, our “rules of the game” are more than guidelines; the set as a whole constitutes a coherent system that covers the use of information and models in a participatory policy process.

Our “rules of the game” are conceptually similar to the rules in the Institutional Analysis and Development (IAD) framework (Ostrom 1999). Nevertheless, they do not easily fit into the seven broad types of rules presented by this framework. Although the participant roles we defined can be seen as “position” rules that define the positions or roles that actors can take, we do not specify “boundary” rules that define how actors can change their position. When our “rules of the game” specify by whom decisions are made, these can be seen as “authority” rules, but we define no “aggregation” rules that, for example, say that a majority of participants suffices to determine whether a decision on the agenda is near closure. We do not specify “scope” rules that define the set of outcomes that can be affected by decisions, nor do we specify “payoff” rules that define how costs and benefits are allocated when a final decision has been made. Finally, we do not specify “information” rules that define the information available to actors in specific positions. Instead, all of our “rules of the game” are based on a single, implicit information rule: all information is to be available to all participants, regardless of their position.

We see the incongruence between the seven IAD rule types and our “rules of the game” as the result of a difference in focus. Within the IAD framework, the rules pertain to the use and management of a common-pool resource, whereas our “rules of the game” concern the organization of a policy process. Ostrom et al. (1994) point out that a set of rules will always be nested in another set of rules that define how and by whom rules can be changed, so our “rules of the game” could be seen as this other set. Still, the relation between these is elusive and merits analysis.

Conditions for Effectiveness

Evidently, rules will be effective only when the actors concerned know the rules and have what it takes to apply them. In the Bargerveen case, the decision-making responsibilities of the government agencies at different levels were formally established in planning procedures. Even so, the process manager put continuous effort into clarifying these formal institutions to the participants. Although the participants were already familiar with the informal institution of the sounding-board group, the purpose of this group and the roles of its members were also made explicit. This essentially corresponded to what we have identified as information-transparency rules (IT-1 through IT-6).

To fulfill her pivotal role in the process, the process manager must have a clear mandate from the process sponsor and also from the other participants (Webler 1995, Reuzel et al. 2007). The role requires special capabilities: some knowledge of the topic under discussion which, in our case, was hydrology and modeling; the capacity to synthesize and summarize information, and track down external information referred to by participants; and above all, the ability to go firmly and consequently by the rules, explaining, and motivating decisions, and to call out of order those who do not observe the rules, regardless of their position.

The process sponsor should commit to the process but, preferably, have and retain the formal authority to decide unilaterally in case of process failure (de Bruijn et al. 2002). Such an overruling decision then becomes the default “or else” for the “rules of the game,” and the process manager can make this explicit if participants cannot be held to the rules by reason. The process sponsor should also be upfront about time and budget constraints, or the process manager cannot properly apply rule AM-1.

Our model-transparency rules focus on establishing what part of the information need the model can satisfy. Similar to the guidelines proposed by Karas (2004) and Caminiti (2004), our rules implicitly assume that the modelers have adequate knowledge and skills, adhere to professional standards (Refgaard et al. 2005, Jakeman et al. 2006), and, even more importantly, are aware of their limitations in these respects.

In sum, the effectiveness of our "rules of the game" largely depends on whether participants have the competencies their role(s) require.

Transplantability

We expect that, in model-informed participatory policy processes, our explicit set of "rules of the game" can help to structure the interactions among actors, thereby enabling effective participation. How much it will help will depend on scale and context. The Bargerveen GGOR had a local character, yet, even so, the sounding-board group was comprised of over 30 members. Adequate stakeholder representation for controversial water management issues on a regional or national scale might entail several times this number. The information-processing capacity required will rise with the number of participants. The capacity of the process manager may be scaled up by forming a project team, but participants may soon find rules AM-2 and IT-4 too demanding to comply with. To avoid this, special support is needed (Enserink and Monnikhof 2003).

Formal and informal institutions are closely related to national culture (De Jong et al. 2002). Hofstede (1983) has shown how national cultures and the related formal and informal institutions they embody differ along four dimensions: "individualism," "power distance," "uncertainty avoidance," and "masculinity." The existence of different national cultures implies that the "rules of the game" that we have defined may be specific to the Dutch institutional context. The Dutch tradition of collaborative decision making reflects its culture of high individualism, small power distance, weak uncertainty avoidance, and low masculinity index values, following Hofstede's dimensions. The same rules may not function in a culture with different index values. The agenda-management rules and information-transparency rules favor an egalitarian process (low power distance), in which participants must feel free to defend their opinions (high individualism) without trying to stand out or dominate (low masculinity). Such rules may be difficult to implement in countries with high power distance (e.g., Belgium or France) or high masculinity (e.g., Germany or the USA). Moreover, De Jong (2004) makes clear that "transplantation" of institutions from one context to another is difficult even when the contexts have very similar institutional characteristics.

The effectiveness of "rules of the game" will also depend on the stability of the institutional context. As Klijn (2001) puts it, rules "only continue to exist if they are continually (re)affirmed by actors either overtly or tacitly." Our rules worked well in a policy process that was legitimized by a formal institution, namely, the GGOR procedure, with participants who were very familiar with policy negotiations. The "rules of the game" we have defined were effective in the Bargerveen GGOR process because most were already part of the "informal institutions" and, hence, implicitly known to and accepted by the participants. In less stable institutional contexts, for example, without a formal procedure embedded in legislation, or when informal institutions for policy negotiations are lacking or favor confrontational behavior, rules need to be negotiated by the actors themselves (Ostrom 1990, Webler 1995, Ehrmann and Stinson 1999, Hajer 2003).

Contribution to the Field

The Bargerveen case has demonstrated the value of the deliberate implementation of an "institutional design," such as the GGOR procedure, for finding ways to protect a vulnerable ecosystem while respecting the socioeconomic interests of the stakeholders. We believe that the results of our reflection on this case may help to improve the management of water resources and their associated social–ecological systems on two levels.

On a practical level, the "rules of the game" that we propose provide a detailed and yet general description of a code of conduct that may serve as a model for future participatory processes. This is not a prescription to be followed indiscriminately, but a "boundary object" (Star and Griesemer 1989): the rules and their "vocabulary" may serve as an "ideal type" of a model-informed participatory policy process. Presenting them as a template in the process-design phase will stimulate discussion about what is "proper behavior" for each actor role, and also about the competences required for each role. This discussion will heighten the participants' awareness of the important role of these "soft" institutions in establishing a fair and transparent process, and in determining the quality of information and the capabilities and limitations of models. This same discussion will help the process manager take into account the caveats concerning conditions for effectiveness and transplantability.

On a methodological level, we have shown how the ADICO syntax for rules proposed by Crawford and Ostrom (1995) can be used, in combination with a conceptual model of a participatory process, to represent at a detailed level the "informal institutions" that underlie such a process. Model and rules may help structure future research. We speculate that the rules we have defined for agenda management and information transparency will apply to a broad range of cases, and may be used as a coding scheme for qualitative analysis and cross-case comparison of process designs and their implementation. One aspect to investigate in more detail would be the relative importance of process design and the level of competence of participants in the role(s) they perform.

CONCLUSION

The particular way in which existing hydrological models were challenged and nevertheless used in the successful participatory development of a water management plan in the Netherlands incited us to analyze the code of conduct of participants' interaction. This has resulted in a coherent system of "rules of the game" that can guide the interaction in model-informed participatory policy processes. Compared to the situation-specific rules (i.e., plans, policies, or institutions) for collaborative resource management that are more commonly discussed in the literature, the "rules of the game" we propose are "meta-rules," as they address the "organization of a process" for developing such plans, policies, or institutions.

We have structured our "rules of the game" in four sets. The first two sets comprise general rules for agenda management and information sharing, based on the notion of "fair and competent process," as reported in the literature. The other two sets comprise more specific rules for using models and proposing policy measures. The rules complement existing modeling guidelines, because they define how to integrate models and information procedurally in the process. They make explicit a framework of informal institutions favorable for the joint development of knowledge, and for a constructive discussion on model limitations. The focus on "fair process" and transparency of model-based analysis enhances the trust-building mechanism that is needed to compensate for the intrinsic black-box character of an existing model.

We recognize that the applicability and effectiveness of the proposed rules will depend on the context of formal and informal institutions already in place. Nevertheless, we contend that the rules provide a useful reference model to support discussion while designing and managing model-informed participatory policy processes. As our set of "rules of the game" also proved useful as a coding scheme for ex-post analysis of a water management policy process, we speculate that the rule-centered language and approach taken in this research will facilitate detailed cross-case comparison of process designs.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol16/iss2/art16/responses/

Acknowledgments:

This research is part of the Integrated Project AquaStress (http://www.aquastress.net) financed by the Sixth European Union Framework Programme for Research and Technological Development (FP6, contract number 511231-2). Special thanks to the water board Velt en Vecht and to the members of the sounding board group. We also thank Katherine Daniell for her constructive comments on earlier drafts of this article.

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APPENDIX 1. Composition of the “sounding-board group” for the Bargerveen GGOR process.

The sounding-board group consisted of 30 delegates in total. The represented organizations are listed below. The numbers in parentheses indicate the number of delegates from an organization.

Governmental organizations

Ministry of Agriculture, Nature and Food Quality
- Directorate of Regional Affairs North (2)
- Agency for Rural Development (1)

Province of Drenthe, The Netherlands (2)

Municipality of Emmen, The Netherlands (1)

Municipality of Twist, Germany (1)

Water board Velt en Vecht (3; 1 board member + 2 staff members not on the project team)

Nongovernmental organizations

SBB – Staatsbosbeheer, region North (4)

LTO – National agriculture and horticulture organization
- region North (3)
- local chapters (of region North) for Schoonebeek and Emmen-Oost (3)

Land division advisory committees for Schoonebeek and Emmen-Zuid (3)

Village council of Zwartemeer (1)

Village council of Weiteveen (1)

Farm owners on the south border of the Bargerveen (3)

Commercial enterprises

Firma Griendtsveen – trader in soil (1)

NAM – subsidiary of Shell (1)