Participatory Modelling – (how) can computer generated information affect the ”room of action” of local stakeholders?

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Abstract

Today, the demand for increased public participation in the management of natural resources and implementation of remedies to come to grips with environmental problems within the environmental field is growing. Increased participation is held to contribute to better, more legitimate and cost-efficient solutions. Local actors' knowledge about the functioning of ecosystems may also increase the quality of proposed solutions. At the same time the use of highly aggregated computer generated scientific information as a basis for decisions and negotiations both at national and international levels has become more and more recurrent. The computer models enable the integration of large quantities of information about environmental causes and effects at various scales in time and space.

This paper discusses what may happen, when computer generated information meets local water stakeholders. The combination of remedies that computer based models suggest are for example not always possible to implement within the limited “room of action” in which local stakeholders are forced to act. May a process of participatory modelling make model generated information more adapted to this “room of action”? Or the other way around is a participatory modelling process a way to affect the size and character of this room? And can this type of method/process be a way forward for creating a critically intervening research?

The paper builds on experiences from two Swedish case studies, one recently terminated, and one just started. Both cases focus on the problem of eutrophication and local stakeholders include farmers, municipal environmental officers, outdoor interests and representatives from other point- and diffuse sources of nitrogen and phosphorous. Results show that this type of participatory modelling may be a good tool for creating a general consensus around the causes, type and possible solutions of certain types of environmental problems. Simultaneously, computer generated information is not always adapted to the complex network of institutions that define the room of action of local stakeholders.

A new political context – combining participatory processes and models when defining solutions to environmental problems

Today, it is widely recognised that detailed regulatory approaches focusing mainly on point sources has not been able to deliver the expected results in relation to several environmental

problems.[1] Many consider public participation as an important factor to a successful sustainable watershed management, especially in relation to non-point source pollution.[2] It is argued that public participation may provide for better-informed general public and remediation plans with higher legitimacy. This, in turn, may lead to more efficient implementation of measures and reduction of conflicts between different stakeholder groups.[3] It is also argued that public participation could replace traditional enforcement activities, and thereby increase the implementation of decided measures and save costs.[4] Moreover it is argued that increased public participation may improve the democratic process by involving people in decision-making processes.[5] In line with for example the EU Water Framework Directive's emphasis on participatory and local democratic processes as an important ingredient in water management, a number of Government Committees dealing with Swedish WFD implementation have emphasised the need for public participation in future water management.[6] To some extent these thoughts are new in the Swedish water management discourse and political reality.

Coincident with the increased request for stakeholder involvement in the implementation process there is an increased demand on natural scientific experts to give more precise as well as comprehensive explanations of the environmental problematique. This is in line with both political ambitions such as the polluter pays principle as well as technical developments increasing availability of computers able to compile large amounts of data. The increased use of computers is especially visible in the environmental field where multi-variable modelling play an increasingly important role in enhancing our understanding of multifaceted environmental problems at the global, national and local scales.[7]

The general understanding of the relation between knowledge about the environment and action to prevent environmental harm is that well-founded scientific knowledge is crucial in order to make change happen. Decision-makers therefore frequently interpret the public's lack of action as a distortion, a technical problem to overcome.[8] This is also one of the strongest arguments for increased public participation. By informing the public, "*making people aware*", it is possible to change individual patterns of behaviour. One suggestion often put forward by decision makers is therefore to increase the amount of given information and to improve its quality with more research. Another suggestion is to improve the communication with better-trained communicators. Today, however, there is an increasing support behind the idea that people's acceptance and actions to mitigate environmental problems is not only a matter of increased flows of information, a technical improvement of the content of the message or the pedagogical skills of for example scientists. Local stakeholders' willingness to engage in participatory initiatives and accept presented information depends on the type of issue, stakeholders' interest, the local institutional context and the design of the participatory process. Stakeholders' assessment and acceptance of scientific information is connected to their social, geographical and economical background as well as previous knowledge and encounters with experts and scientific information.[9] Stakeholders' decisions regarding remedy

1 See SOU:1997:99:13 for an account of OECD's criticism of Swedish detail regulation and individual permits. See also Hallgren, 1997:19.

2 Johnson, N., Munk Ravnborg, H., Westerman, O. and Probst, K. 2001, Swallow, B. M., Johnson; N. and Meinzen-Dick, R. S. (eds) 2001, Blomqvist, A. 2004, Andersson, L., Bonell, M. and Moody, D. W. 2004, Liedberg Jönsson, B. 2004, Creighton, J. L., Dunning, C. M., Priscolli, J. D. and Ayres, D. B. 1998.

3 Montin, S., 1998, Lauber, T. B. and Knuth, B. A. 2000, Priscolli, J. D. 1998. Hanchey, J. R. 1998, Ostrom, E. 1990, Ostrom, E., Schroeder, L. and Wynne, S. 1993.

4 Marshall, G. R. 1999, Munch, P. 1998, Forrester, 1999.

5 Olsson, J. and Montin, S. (eds), 1999, Beierle, T. C. 1998,

6 Ministry of Environment 1997, 1997, 2000 and 2002.

7 See for example Darier, E. et al. 1999, Edwards, P.N. 1999, Yearley, S. 1999.

8 Sarewitz, D., Pielke, R.A. and Radford, B. (eds.) 2000,Yearley, S. 1999, Yearley, S. 2005.

9 Irwin, A., Dale, A. and Smith, D. 1996, Wynne, B. 1992, Irwin, A. 1995.

implementation depend on the factors influencing their participation, their acceptance of scientific information as well as the existing system of legal and economic incentives.

There are hence two parallel developments influencing the form as well as content of today's environmental management, both with the aim to increase the efficiency and legitimacy of environmental policy: One is the change in the political process of environmental management emphasising the potential of participatory and local democratic processes. The other is an increased use of highly aggregated scientific information produced by experts as a basis for stakeholder dialogues. Frequently these two developments are intertwined and participatory processes are supported by computer-generated information. Several initiatives to actively involve local stakeholder groups in water resource management at the catchment and sub-catchment levels have recently been carried out. Some of them have used relatively simple scientific information whereas others have used more complex and elaborated sets of information as a basis for the participatory activity.

This development raises major scientific and practical questions regarding what participation is or should be both in relation to degree, content and form of participation and the use of model outputs. It also raises questions about the potentials and limitation of using model-produced information as a communication tool between decision-makers, different groups of stakeholders and experts in environmental policy-making.

This paper mainly builds on experiences from two Swedish studies, the Rönneå Catchment Dialogues, recently terminated, and the DEMO-project, just started. The DEMO-study is based on a methodology called participatory modelling which is an iterative exchange of information between experts and local stakeholders co-producing computer based scenarios for water management. Both cases focus on eutrophication and local stakeholders include farmers, municipal environmental officers, outdoor interests and representatives from other point- and diffuse sources of nitrogen and phosphorous. The stakeholder groups were identified by their potential and importance for solving the eutrophication problem.[10]

Aim

This paper aims to discuss what may happen, when computer generated information meets local stakeholders within a participatory context. Of specific interest is if, and how, a participatory modelling approach may increase the implementation of remedies by affecting the "room of action" within which local stakeholders act. By investigation this, we hope to be able to pinpoint the most crucial barriers to participation, constructive use of model results, and effective remedy implementation. The paper seeks at understanding the patterns of interaction and the establishment and maintenance of participation, acceptance and remedy implementation, rather than on explaining or predicting possible outcomes, or evaluating any efforts or results. The analysis requires a qualitative, and to some extent also explorative approach to the issues in focus.

Based on this aim, three more specific research questions have been formulated:

- May a process of participatory modelling make model generated information more adapted to the stakeholders "room of action"?
- Is a participatory modelling process a way to affect the size and character of stakeholders' room of action?
- And can this type of process be a way of creating a critically intervening research?

10 See Jonsson et al, 2005.

Theoretical points of departure

The institutions in a society, such as rules and norms provide *a structure for human interaction*.[11] This structure has a decisive influence over how resources are used within and allocated between different sectors. In order to understand these processes, an analytical framework that focuses on the creation and change of incentives and norms and values, and their impact at the micro-level is essential. One theoretical point of departure is that individual rationality is embedded in a social context, and that each individual is restrained by a number of concerns, for instance those pertaining to the individuals' roles as a community member. Global, national and local social, economic, cultural and political relations are seen as important variables for understanding the decision-making of individual stakeholders.

It is not always realistic to assume that increased participation and better use of computer-based results will automatically leads to increased implementation by stakeholders at the local level. Stakeholders operate within their specific "room of action". Both formal factors such as legal regulations, market prices, taxes, fees and subsidies, and informal factors such as norms and values of the stakeholders define the "room of action" within which individuals take their decisions on resource use and management.[12]

Factors influencing stakeholders' commitment in an participatory environmental process

Several factors influence the degree of success of stakeholder involvement in a participatory environmental modelling process and the degree of implementation of remedies. They can be grouped into the following three categories:

- Factors influencing the willingness of stakeholders to invest time and resources in *participating* in the process.
- Factors influencing the tendency of stakeholders to *accept* model results as legitimate descriptions of local eco-systems.
- Factors defining the "*room of action*" for stakeholders to implement remedies suggested by model results.

The "room of action" is in no way fixed. Policy changes at the global and national levels constantly affect the room of action. Local institutional development may also affect the room of action of local stakeholders. Stakeholders are also able to widen their room of action by working as an interest organization or as a social movement with a green agenda. By using arguments, expert knowledge and model results acquired stakeholders may further their interests in a wider and long term political context.

A room of action can be more or less "comfortable" and when discussing the possibility for remedy implementation it is also important to understand how "comfortable" the room of action for remedy implementation must be to get any remedies implemented.

Method and design of the study

The paper is based on two types of empirical material. Firstly, earlier studies where model results have been used in a participatory context, such as the Genevadsån,[13] Emån,[14] Svartån,[15]

11 North, 1990:4. For similar definitions see, for example, Ostrom, 1990.
12 See Ostrom, 1990, pp 192–206 for a discussion about the internal and external world of individual decision-makers.
13 Wittgren et al 2000, Wittgren et al 2005.
14 Blomqvist 2004.
15 Andersson et al 2002.

CATCH,[16] and Rönneå[17]-studies. Of these, the lion's share of the material used comes from the Rönneå-study. Secondly, some preliminary results from the DEMO-project[18] have been incorporated into the discussion.

The paper is of an explorative character and aims to increase the understanding of what is happening when computer-generated data meets local stakeholders in a participatory context. It draws conclusions concerning and give examples of factors influencing stakeholders' participation in environmental modelling and acceptance of model results from the case studies mentioned above. Based on these conclusions, the paper also discusses the relation between stakeholders' involvement in participatory modelling and effects on the room of action. The paper ends in a discussion on to which extent a participator modelling process may result in a critical intervening research.

Stakeholder participation in environmental modelling and acceptance of model results

In the following section we will explore different factors influencing stakeholder participation in environmental modelling and acceptance of model results. Eight main factors affecting the willingness of local stakeholders to participate and their tendency/willingness to accept model results are discussed in relation to a participatory modelling process.

Willingness to participate

Mustering public participation in environmental issues generally, and water resource management specifically, is not an easy task. Experiences from Agenda 21 show that a main challenge is to attract enough interest and readiness to participate among the public and stakeholders, especially in the long run.[19] A modern hectic lifestyle and a massive flow of information are two reasons referred to in several studies.[20] A well functioning water service is another; *"I think it is difficult. We are spoiled because we have water in the tap, and we can flush the toilet, so therefore I don't think we are likely to become actively involved."*[21] Simultaneously, public participation is considered an important contribution to successful sustainable watershed management.[22] Below, four factors that are crucial in affecting stakeholders' willingness to participate are presented.

Type of issue at stake and perceived potential/need for real influence

The types of issues around which stakeholders are invited to participate have a heavy bearing on the willingness to engage. Earlier research shows that the more local and tangible the issue, the higher is the tendency for all types of stakeholders to actively participate in meetings,

16 Collentine et al, 2002, Collentine et al, 2005.

17 Jöborn, and Danielsson 2005, Jonsson, Danielsson and Jöborn 2005.,Alkan-Olsson and Berg 2005, Jonsson 2005.

18 The DEMO-project is a recently started research project funded by FORMAS. The aim is to further investigate and develop methods for participatory modelling. The active involvement of stakeholder in such a process entails the participation in a sequence of meetings over a longer period of time, in the DEMO-case 2-3 years. The preliminary results presented concern farmers, as this is the stakeholder group so far involved. Environmental officers and houseowners without appropriate treatment of household effluents will be involved during summer/autumn 2005. During spring 2005, 12 meetings with farmers within the Kaggebo-catchment situated in Östergötland and Kalmar Countries have been conducted. The meetings focused on two-way communication of information on local conditions using detailed maps of the catchment and sub-catchments, and general descriptions and discussions of the model and what type of results it may produce.

19 Eckerberg and Brundin, 2000, Edström and Eckerberg, 2002 and Forsberg, 2002.

20 Jonsson, 2004, 2005, Collentine, 2005.

21 Rönneå dialogue participant, see Jonsson, 2005. See also Gooch et al, 2003

22 See Section 1 above.

discussions, decision-making and implementation.[23] This is also supported by results from the Rönneå and DEMO-studies. *"It is not until it happens on **my** yard, to **me**, in **my own** small house that I really care. But if there are plans to construct a motorway straight through the village, then people will surely engage!"*[24] Abstract goals and concepts like "good water status", "catchment-based management" or the EU WFD, are difficult for people to connect to their daily life and local surroundings. Such concepts need to be translated into a local language to be interesting for local stakeholders, through for example informal conversations in the local grocery store and similar.[25] In the DEMO-project, it is evident that meetings at the sub-catchment levels draw more people than meetings for the whole Kaggebo-area, and that the further away from the eutrophe Kaggebo Bay a sub-catchment is situated, the lower is the interest from local stakeholders to participate. Thus, the more concrete a discussed problem is, the more likely is it to touch local identity and proliferate in the local discourse.

Another crucial component affecting the willingness of stakeholders to participate is the perceived potential for real influence in the decision-making process concerning the matter at stake. If participation is not expected to have any impact on the formulation of future solutions, the reason for engaging are, of course, meagre. Similarly, participation initiatives where stakeholders have been given real influence have often been successful in engaging people.[26] Preliminary results from the DEMO-process show that participants value the potential of real influence very high, and the prospect of the initiative turning into *manipulation* or *therapy*[27] is openly considered as a risk by participants.[28]

As shown in the Rönneå study, the perceived need for participation may also affect the willingness to participate. Many feel that environmental issues are best taken care of by experts and see little need for stakeholders to engage.[29] *"My opinion is that in the first phases it should be those who actually understand the issue who should summarise the situation so that Svensson and Andersson get some kind of fact-based description of the problem. Not just ordinary persons. But I am one of those who don't understand very much, so I can't actually say anything about it."* [30]

Type of stakeholder interest and characteristics of stakeholder group

The willingness to participate also depends on which type of stakeholder group an individual belongs to, in terms of economic dependence on the resource and expected economic outcomes related to the issue at stake. In the case of eutrophication, individuals belonging to groups that may suffer increased costs of production (farmers) or living (rural households) may appear to have a stronger reason to participate than individuals belonging to groups with a more peripheral interest in the issue (recreational interests). Farmers are directly dependent on the water resource for livestock, household water and sometimes irrigation but may also incur considerable costs for remedy implementation. Treatment of household effluents is a delicate issue for many rural house owners.[31] Therefore, to actively engage in a participatory modelling process focusing on eutrophication may be considered as deliberately "putting one's hand into the bee-hive".

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23 Jonsson, 2005, Forsberg, 2002.
24 Rönneå dialogue participant, see Jonsson, 2005.
25 Jonsson, 2005.
26 Forsberg, 2002.
27 Arnstein, 1969, Jonsson, 2004.
28 See also Section 6.2 below.
29 See also Eckerberg and Brundin, 2000, Forsberg, 2002, Lundqvist (ed) 2004.
30 Rönneå dialogue participant, see Jonsson, 2005.
31 The high cost of treatment, expert doubts on efficient technologies, varying strictness of law enforcement, and a lack of any immediate benefit for the individual undertaking this investment, renders the issue low priority in most household budgets (Jonsson 2005).

Some earlier studies show that farmers may be increasingly motivated to engage in collective remedy implementation if some private economic carrot is offered.[32] Experiences from the Rönneå and DEMO-studies show that this is not of crucial importance for the willingness to participate in an environmental modelling process, though. In these cases, the room of action for remedy implementation, the possibility of affecting the room of action and the risk to get bee-stung seems more important.[33]

Another factor is how well organised a stakeholder group is in terms of social, administrative, political capacity and knowledge. LRF, for example, acts as a strong interest organisation for farmers both at the national, regional and local levels, while rural house owners lack any similar type of organisational strength to pursue their interests. Individuals as well as the local organisations belonging to well-organised stakeholder interest generally have more resources to engage in activities outside their immediate day-to-day routines. This can be compared with experiences from Agenda 21, showing that well educated citizens and well organised stakeholder groups more often were engaged, while immigrants, women and lower socio-economic strata were involved to a lesser degree.[34] It also seems important in which capacity you are invited. "Professional" stakeholders (i.e. municipal environmental officers) may find it easier to find time and resources to participate than "lay" stakeholders (i.e. rural house owners) may.[35] Farmers however seems to encompass both of these categories.

Local institutional context

Stakeholders make their decisions on whether to engage in a certain issue or not in a complex network of local social, economic, religious and cultural institutions manifested in local collective memory.[36] The existence of "social capital" seems to play a very important role in affecting local stakeholders in their decision to participate or not. Some important social, economic and cultural networks in the Swedish countryside include the local branches of LRF (parish level), hunting and fishing associations, machine co-operation, power/drainage/water regulation enterprises, local community organisations ("byalag"), football teams, road associations and other legally regulated co-operative economic associations ("samfälligheter"), and the parishes.[37] Earlier efforts of stakeholder involvement in interactive modelling exercises have successfully recruited participants via the LRF network.[38] Efforts to recruit participants from other, more loosely organised stakeholder groups have been more problematic, though.[39] Randomly sampled invitations to potential participants give even lower involvement ratios.[40] Thus, if a participatory initiative can link into a strong local network of some kind, individuals involved in that network will be more willing to engage in the new initiative as well. Depending on which network a participatory initiative is choosing to link up with, different groups and sub-groups of stakeholders are likely to become involved. Obviously, the gatekeeper function of existing network strongly guide who is likely to engage and not, and makes it less probable that individuals involved in other or no networks will participate. Moreover, linking up with existing local networks that function with high friction, or do not function at all, can create considerable difficulties for interactive modelling processes and future institution building. Conflicts between families or sub-groups

32 Söderqvist, 2001:50. Compare Olson's (1965) discussion on "selective incentives" for controlling free riding.
33 See also discussion in Section 5.2 below.
34 Wide and Gustavsson, 2001.
35 Edstam, 2004, Jonsson et al, 2005.
36 Lundqvist, 2001, Blomqvist, 2004.
37 Blomqvist, 2004.
38 Andersson et al 2002, Wittgren et al, 2005, Jonsson et al, 2005, and the on-going DEMO-project.
39 Jonsson et al 2005.
40 Collentine et al, 2005, and Gooch et al, 2003.

of stakeholders may have a history of generations and centuries,[41] something that is not likely to enhance either willingness to participate in a constructive discussion. (See also section 5.1 and the integration effect)

Lastly, but certainly not least, the role of *fire souls*, [42] i.e. political and social entrepreneurs who burns of passion for various issues of local collective concern, must be highlighted.[43] Such persons often constitute one of the main driving forces for the creation of a local stakeholder group and or creating good potential for public participation. A fire soul is often active in several different local networks, social, economic, political, cultural and/or religious, and may, as in the DEMO-study, play a very important role in linking the participatory environmental modelling initiative into a local network. At the same time, any dependence of fire souls also makes the process vulnerable; as it depends on the continued enthusiasm, interest and health of these few persons.

Design of meetings

From the perspective of those who initiate a participatory environmental modelling process, few of the factors discussed above are easy to change. What can be affected, though, is how the process itself is designed. The type of engagement advisable in this context is rather long-term and demands a lot of enthusiasm, time and will of the participants to work. Therefore, it is important that the design of each meeting during the process strives to optimise both long-term and immediate benefits for individual participants.[44] As discussed above, invitations reaching participants via a well-known local network may lower the barriers to come. An invitation from an organisation which local stakeholders do not know, or do not trust, to a meeting conducted at a non-familiar venue a long distance from home certainly appears less tempting than an invitation via the local LRF-division to a meeting at the local parish hall. For individuals belonging to a loosely organised stakeholder group, no such networks and meeting places may exist. Instead other types of local events such as Christmas fairs, midsummer festivities, markets etc., may create a chance for potential participants to "*stumble on an issue*" or experience "*a happening for the whole family*".[45]

From the Rönneå study several aspects of process design highly valued by participants could be identified. One was the opportunity for two-way communication and exchange of knowledge, both in-between participants and between participants and "experts".[46] Particularly, the collective learning experience and the meetings were several different stakeholder groups met were appreciated. The use of a facilitator who chaired the meetings was also highly valued by participants.[47] From the DEMO-study, preliminary results show that participants expect "to learn something", social interaction, and an efficient use of valuable time to discuss concrete issues with immediate relation to their day-to-day routines. Meetings with a diffuse agenda, without any component of presentation of facts by the "experts" and no time for coffee and a god chat are clearly less appreciated.

Willingness to Accept presented scientific information

Local stakeholders' willingness to accept presented information is related to their social, geographical and economical background as well as previous knowledge and encounters with

41 Blomqvist, 2004: "… *my father said to him already in the 1920s that he should get down from his high horses*…", See also Lundqvist, 2001.
42 "*eldsjälar*"
43 Blomqvist, 2004, Andersson et al, 2004, Forsberg, 2002.
44 Jonsson et al, 2005.
45 Rönneå dialogue participant, see Jonsson, 2005., see also Edström and Eckerberg, 2002.
46 Jonsson 2005.
47 Edstam, 2004, Jonsson et al, 2005.

experts and scientific information.[48] An amplified flow of scientific information and its increased complexity make it more and more difficult for local stakeholders to assess and criticise expert knowledge. Simultaneously it is held, especially from the perspective of decision-makers, that a common understanding and a collective learning of environmental problems is crucial for a quick and efficient solution to environmental problems. Below, four factors affecting stakeholders' willingness to accept model-generated information are presented.

The use of data

The confidence in the practical application of the model-generated data is crucial for the willingness to accept model results. Earlier research shows that if the future application of the information is unclear or unwanted local stakeholders are less likely to accept presented data.[49] This is also supported by findings form the Rönneå study, where several participating stakeholder groups feared that the produced data could result in decisions that would be disadvantageous or unfair. *"I am a bit afraid of the conclusions drawn from these discussions. There are lots of theoretical things and academic conclusions, which are not possible to launch or even implement. These problems are so complex and I feel that VASTRA[50] has generalised very much when it concerns the state of the art and identifying which are the problems. It is not as simple as those dots on the map show."*[51] Thus, an unclear link between the presented data and their practical use is likely to decrease the acceptance of any produced and presented information.

In the Rönneå study uncertainties in the produced information such as the vague link between taken measures and effects on the environment and the use of standard values to estimate pollution from the farm sector was identified as a problem. *"It is important to know the proportion of pollution from different sectors. From the sewage treatment works there are good numbers, but for rural households and farmers there are only estimations."*[52]

Another important issue was the idea that the models and their output did not take into consideration the effects and implication of economic realities and legal restrictions. It was for example argued that the presented models were not able to handle conflicts between the achievements of the eutrophication goals and salmonella prevention. The models were also seen as unable to relate the problems and proposed solutions to the broader economic and political context such as the Common Agricultural Policy. Such an inability has also been highlighted in other studies.[53]

Personal characteristics of the stakeholders

The factors influencing the acceptance of model generated data are to several extents similar to the type of stakeholder group that the stakeholder belongs to (see section 4.1.2). However, when it comes to acceptance of model generated data; individual characteristics seem to be even more influential. The willingness to accept is influenced by the stakeholders' social, economic, educational and geographical background. In the Rönneå study the profession turned out to be the most important factor, and farmers constituted the most critical stakeholder group. A major reason for their critical attitude can be linked to the feeling of being targeted as the main source of pollution. It can also be linked to their professional

48 Yearley, S. 1999, Yearley, 2005.
49 See for example the case studies presented in Eds. Kasemir et al. 2003.
50 Swedish Strategic Water Management Programme, within which the Rönneå study was conducted.
51 Rönneå dialogue participant see Alkan Olsson, J and Berg K., 2005.
52 Rönneå dialogue participant see Alkan Olsson, J and Berg K., 2005.
53 Yearley, S., 1999 and Schakley et al, 1997.

knowledge of soil processes as well as earlier experiences with measuring environmental pollution especially among livestock farmers.[54]

Younger participants were generally more positive towards models and their outputs, a young farmer stated. "*For me, these findings* (referring to the presented scenarios) *seem reasonable and we have to do something. The work with, for example Fork the Manure* [55] *is positive. I see that we can do a lot if only someone could tell me what to do."* [56] The older generation was generally less enthusiastic and referred frequently to the fact that measures had been in place in the Rönneå region for a long time but no radical improvement was visible in the model generated data.

Trust and influence of different stakeholder groups

Stakeholders' acceptance of presented data is not something without a link to the history. Several studies have indicated that the present understanding and acceptance is deeply influenced by previous encounters and experiences with experts, decision-makers and other stakeholder groups.[57] In the Rönneå study the participants expressed on various occasions a lack of trust in experts and political bodies, particularly regarding the definitions of environmental standards. *"We have the environmental standards. The Farmers' Union has provided some figures of the levels of nutrient leakage, and the County has provided some, the EU has provided some numbers and all of them are different. In this context I wonder, which figures VASTRA have used?"* [58] Stakeholders' acceptance of the model-generated data was also affected by their view on how decision-makers were able to manage environmental problems. *What is happening during one term of office for those who are in power in a country or in the EU? It is a too short period of tenure! Then they have the next election to think about… Now we are talking about processes, but it takes at least 20 years before a taken measure can be evaluated. During these 20 years the direction (referring to political direction, authors note) could have changed already three times.*"[59]

Moreover, the acceptance of presented information can also be associated with the stakeholders' relation to other stakeholder groups. In the Rönneå study this issue was brought up in a discussion about the role of the traffic to the eutrophication problem. Rönneå participants become suspicious when deposition from the traffic was not easily visible in the model-generated data, which in turn stirred up already existing tensions between urban and rural inhabitants. A similar discussion also materialised in relation to whom should bear the burden of the pollution from food production, the farmers living in the countryside or the consumers predominantly living in the cities. This can be closely related to the factors influencing the willingness to participate discussed in previous section. A group hosting several internal conflict or tensions stakeholders are more unlikely to accept presented information.

Media have also an influential impact on the publics understanding of environmental problems in general. In the case studies stakeholders referred to how the eutrophication issue had been presented in the media. When presenting environmental information to a group of local stakeholders media's description of the issue at stake is therefore likely to be influential. During the Rönneå study, the moderator on several occasions mentioned that pollution from the traffic was included in the model. Even so, numerous stakeholders argued that the share of pollution emerging from the transport sector was not taken into consideration properly or

54 Alkan Olsson and Berg, 2005.
55 Greppa näringen.
56 Participants in the Rönneå dialogues, Alkan Olsson and Berg 2005.
57 Mc Granahan, and Gerger, 1999.
58 Participant in Rönneå dialogues, Alkan Olsson and Berg, 2005.
59 Participant in Rönneå dialogues, Alkan Olsson and Berg, 2005.

mirrored in the model-generated data.[60] This argument could be interpreted as a flaw in the communication between scientists and the participants. However, a more plausible interpretation is that this problem also closely connected to the history of the scientific information spread within the region. The Rönneå catchment is situated in one of the most densely populated areas in Sweden where the deposition of pollutants originating from traffic is relatively high, and therefore a considered as a problem. This argument has on several different occasions been put forward in the local media first in relation to the acidification problem and later in relation to a possible increased traffic in the south west of Sweden due to the construction of the bridge between Sweden and Denmark.

The way the model generated data is communicated

For the initiators of a participatory environmental modelling process, few of the factors discussed above are easy to change. What can be affected, though, is how the process itself is designed. As for the acceptance of the information a crucial aspect is of course the agenda of meetings and the design of stimulus material and the way the data is communicated [61] (see also section 4.1.4). In the Rönneå study, a circumstance that clearly had an adverse effect on the participants' acceptance was if they felt accused or singled out as the guilty persons. In the Rönne å study the farmers saw themselves as blamed for natural leaching as well as other undefined sources of pollution. They argued that it is too narrow minded and unconstructive to blame the farmers. Instead they insisted that the problem related to leaching from the farm sectors had to be discussed in a larger perspective, questioning the scope and interpretation of the polluter pays principle (see also section 5.2.2).[62]

Yet another factor was related to the composition of the group in which the discussions took place. The critique put forward against the model-generated data was stronger when the stakeholders met in homogeneous groups, whereas less critique came up when they met in the heterogeneous groups. This may partly be due to the fact that less scientific information was given in the hegerogeneous groups[63] Another reason may be that in the homogeneous groups in Round I, the "common stake" served as a catalyst, encouraging stakeholder to submit more critique, whereas they tended to be more diplomatic in the heterogeneous groups. This tendency was visible especially in the homogeneous meeting with grain farmers.

Moreover, the acceptance of the model generated data was also dependent on time, the longer time the stakeholders had been exposed to the provided information the more positive they were. Towards the end of each meeting as well as in the personal interviews, participants were more positive towards the model-generated data than in the beginning. Several stakeholders argued that they saw the whole event as a "mutual learning process".

The geographical scale on which the model output was discussed also influenced the acceptance especially of generalizations and standard values used in the model and in the description of processes. At the catchment level the participants thought that the model generated an interesting and comprehensive picture of the eutrophication problem. This, they felt, was important and instructive *"an eye opener"*. One point source polluter said that; *"Irrespective of the model, it is just the fact that there is a model to evaluate the contributions from different stakeholders. I think it is fundamental."* The management scenarios were also appreciated by many of the River dialogue participants who argued that the models had pinpointed several aspects of the eutrophication problem that had previously been unknown or overlooked. One example was the problem associated with untreated effluents from rural households. A majority of the participants also felt that the presented model-generated data

60 Alkan Olsson and Berg 2005.
61 Pahl-Wostl et al 2000.
62 Alkan Olsson and Berg, 2005.
63 Jonsson et al, (2005).

gave a good basis for discussion with the other stakeholder groups. The discussions seemed to increase mutual respect and understanding, as well as showing that the different groups of stakeholders had a more common approach than they initially had thought (see also section 5.1 and the integration effect).

However, the more local the discussions were, the more doubts were expressed. On the very local scale, stakeholders viewed themselves as experts. This meant that they went into detailed discussions concerning the share of pollution from polluters and the history of land use. As the participants felt more knowledgeable and engaged in the discussion at the local scale it made the presentation and use of standard values in the models and the result of the scenario running in the model less credible. This reaction among stakeholders is different compared to the reactions in the Svartå study,[64] where standard values for nutrient leaching from different soil types and land uses were, seen as a valuable information that could be used to compare conditions at the own farm with the average in the region. The difference in the reactions between the otherwise quite similar Svartå and Rönneå studies may be linked to the fact that the participants in the Svartå catchment were involved in the modelling activities at an early stage. For the Rönneå participants, however, the first contact with model-generated data was the already defined management scenarios. This illustrates that the context, time as well as the perceived motive for using scientific information as well as the trust in scientific institutions also may influence the understanding of the model-generated data.

Participatory environmental modelling and the room of action

Ultimately, what will count for improving the environmental status is the implementation of remedies at the local level, both by individual actors and groups of actors. In the case of eutrophication, individual implementation concerns all sorts of geographically optimised remedies, such as changes in manure dispersion, creation of smaller wetlands and installation of new individual wastewater treatment facilities. Collective implementation may concern remedies for which scale and/or economy of scale is crucial, such as larger strategically placed wetlands and common wastewater treatment facilities. Here, the concept of "room of action" for remedy implementation becomes central. In their daily lives, local stakeholders make decisions (affecting nutrient leakage) of many different types. Different stakeholder groups are confronted with different decision-situations, and face different rooms of action defining their possibilities to act. Farmers are estimated to make on average 200 decisions every day affecting nutrient leakage from their land. Most of these decisions are very small and short term, a crop season or shorter, for example, whether to plough closer to the edge of a field edge or not. Others have more far going consequences in terms of needed investments, durability of investment etc. such as the lifespan of machinery or whether to invest in a larger storage capacity for manure or not to reinvest in the ditching and draining of a field. Others still, are almost existentialist in character, such as whether to go on as a farmer or not. Some decisions are of a collective character and therefore the outcome is dependent on other actors' decisions. Thus, the room of action for the implementation of individual remedies is somewhat different than the room of action for remedies building on collective implementation. In either case, though, decisions on remedy implementation take place within the "room of action" available for each individual stakeholder.

As discussed above, the room of action is defined both by incentive structures created by the formal institutional framework at aggregated levels, such as economic and legal incentives, and of the norms and values of the individual, the stakeholder group and the local community. After having investigated the conditions for participation and model acceptance in a participatory modelling process, this section discusses the title question of this paper – to

64 Andersson, 2004, Andersson et al, 2002.

what extent and how may participatory modelling influence the "room of action" for remedy implementation?

Informal incentive structures and the limitation/potential of participatory modelling

The collective learning process that is likely to emerge during a participatory modelling process creates a potential for changing and altering of the informal incentive structure, i.e. the norms and values of local stakeholders. However, this is in no way a clear-cut process and there are no plain answers to whether and when these types of processes may increase stakeholders' room of action. The possible effect of a participatory process on stakeholders' norms, values and attitudes toward the issue at stake are of course depending on a long range of factors such as those discussed earlier in Sections 4.1 and 4.2. In combination, three potential effects on norms and values of stakeholders and experts can been identified; the education-effect, the integration-effect and the perspectivity-effect.

The education- effect is the potential effect of the learning inevitably taken place during a participatory modelling process. This learning is something, which affects both the stakeholders and the experts. Stakeholders witnessed that they through the meeting had learnt more about the eutrophication problematique. As discussed previously the output of the models lent themselves to discussion and criticism from the stakeholders. The criticism mainly arose into two headings: the first, how much the models could tell us that is relevant to the stakeholders decisions; and the second, what sort of message are they, what use are their outputs are they estimates or even guesses? A participatory modelling process could be an ideal forum for which environmental issues could be aired. It is not question of an "emperor's clothes" situation but a situation where local people may air their confusions and reservations about these scientific instruments and the experts may learn about different aspects of the usefulness of their tools in a policy process. Or by using other words a participatory process may make the model generated information more adapted to the stakeholders "room of action".

It is clear form the case studies examined here as well as in other studies where model generated information have been used as a basis for policy discussion in environmental management that model results have an integrative effect both regarding different stakeholder groups and scales. Several participants in the Rönneå study have described this unifying force of model produced data as it serves as a common knowledge base. This common foundation increases the understanding of the eutrophication problem as a catchment based problem, thus, uniting different stakeholder groups within the catchment in a common problem understanding. Trough this integrative force participatory modelling may also be able to repair old misunderstandings and misconceptions in the local institutional context, thereby lowering transaction costs by saving both time and money. From this perspective the model-generated information serve as an "anchoring devise"[65] or a "boundary object"[66] where a broad community of meanings spanning diverse social worlds and perspectives may converge into a consensus. Boundary objects are plastic enough to adapt to local needs and constraints, yet robust enough to maintain a common identity across sites.

The third effect is the perspectivity effect. This is effect is a result of discussions over and between different stakeholder groups, which almost can be described as a collective learning of differences in perspectives. From the Rönneå study several participant have stated that the models and the scenarios were seen as useful for enlarging the scope of peoples' imagination about the eutrophication problematique, they were an "eye-opener". The discussions in the

65 van der Sluijs, et .al 1998 (glöm ej lägga till i ref listan.
66 Star et al (1989).

meetings were also seen to have increased the understanding of other stakeholders' agendas as well as of the own. In the light of other stakeholders comments the new possibilities were identified. Jerry Ravertz have in a similar contexts described the role of models and model generated information as almost "poetic" in the sense that they are able to extend our imagination and perhaps even our affection and sympathy. [67]

As a consequence it could be said that it is the participatory modelling process as a whole that contributes to the enlargement of the room of action creating the glue between stakeholder groups, diminishing the transaction costs for any future collective actions.

Formal incentive structures and the limitation/potential of participatory modelling

The formal economic and legal structure of incentives that affect local stakeholders' room of action influencing the implementation of remedies against, for example, eutrophication, is difficult for a participatory modelling initiative to influence directly. Experiences from previous studies emphasise that it is crucial to clearly define and communicate the limitations of the used models to participating stakeholders, and that the role and purpose of scenarios used are well defined so participants understand what such a process may give and what it may not give.[68] Indirectly, however, there are at least two ways in which a participatory modelling process may change the formally defined room of action for remedy implementation.

Increase the visibility of the room of action

Even if the models used are not able to handle issues such as possible effects of changes in the CAP and contradictions between existing legal tools, a participatory modelling process may highlight which remedies and combination of remedies could comfortably be implemented by stakeholders within their room of action. As discussed earlier, one of our theoretical points of departure is that actions that can comfortably be carried out within the available room of action are more likely to be taken than others. This means that remediation measures that are profitable for the individual are implemented to a greater extent than costly ones. If model results can show that certain practices are both profitable for the individual farmer, and cost-effective in reducing nutrient transports, the rate of implementation may increase. By choosing scenarios and scenario combinations, models make the room of action more "visible" and hence increase the possibilities to act. This change in visibility is thus closely connected to what was discussed about the "education-effect in section (5.1).

A change of the visibility in the room of action can only be achieved if the chosen scenarios are relevant to stakeholders. Model scenarios should therefore include the most popular (profitable/heavily subsidized) land management practices. To model expensive, unprofitable or unsubsidized practices will not give realistic images of potential futures and it is instead likely that the "visibility" of the room of action actually shrinks. Thus, scenarios and combination of remedies should be adapted to the formally defined room of action to increase the utility of the model results in a participatory process.

Change the form of the room of action

In a short-term perspective the scope of a participatory modelling process is not likely to change the components defining the formal room of action of local stakeholders. However, a participatory modelling process may also highlight aspects of the present room of action that are unwanted or "uncomfortable" from the perspective of the stakeholders and thus indirectly

67 Ravertz, J., 2003.
68 Jonsson et al, 2005.

serve as a basis for political action related to the structure and availability of, for example, incentives. Thus, a participatory modelling process may also have a proactive effect. In the relative confusion surrounding the Swedish implementation strategy for the WFD and the definition and the testing of the defined environmental goals, local, regional and nation interest organisations have large opportunities to influence future organisation and routines for implementation.

If model scenarios indicate that the cost-effectiveness of land management practices which were not known before this "new" knowledge may serve as a basis for changes in the systems for subsidies. If model results can indicate the most cost-effective localization of specific remedies such as for example large strategic wetlands as discussed above, administrative rules may adapt to more localized zoning of rules.

Model results may hence help to highlight systematic problems in the formal incentive system. An example of such a systematic problem that was brought forward in earlier sections the interpretation of justice. From the perspective of the Rönneå stakeholders equal treatment of stakeholders was deemed as a more important sign of justice, than a justice and equality based on economic efficiency and a strict interpretation of polluters pays principle.

Participatory modelling – a critically intervening research leading to more efficient remedy implementation?

The 7th of the Swedish Government's 15 National Environmental Quality Objectives is *no eutrophication*. Within the time perspective of one generation this goal shall be achieved by reducing N loads to surface water and seas with 40 per cent.[69] This level of ambition regarding N losses is also consistent with the HELCOM agreement and demands very strong measures to be taken. In order to achieve the reduction in total nutrient losses, the SOU 2000:52 recommends the development of and efficient legal system as well as efficient economic and informative incentives that go beyond previous incentives. With the gradual implementation of the EU WFD catchment based water management administration and the use of hydrological models to estimate source distribution and develop scenarios of different remedy combinations, the importance and use of this type of information is increasing. This paper has discussed what may happen when computer generated information meets local water stakeholders in a participatory context. It was found that participatory modelling can only influence the formal aspects of the "room of action" to a limited degree. It may change the visibility of the room of action and it may serve as a basis for proactive activities, such as lobbying or other types of political pressures. The potential for changing the informal aspects of the room of action is higher, but also limited by context specific factors. Two issues still remain to be discussed, though. The first is whether a participatory modelling approach may actually increase the total level of remedy implementation. The second is which questions and perspectives that must be actualised to ensure that researchers involved in participatory modelling retain their perspectivity and ability for critical reflection.

Will a participatory modelling improve remedy implementation?

Even though a participatory effect have been identified as both directly and indirectly influencing stakeholders' room of action there are several possible backlashes. Built into the expert produced information used, as a lubricant in the participatory modelling process is a potential communication barrier between non-experts and experts. Firstly, the integration of multiple disciplines and aggregation of large amount of data is persuasive and unifying.[70] Secondly, the integration and aggregation makes the model generated data impenetrable and

69 SOU 2000:52.

70 Latour, 1990 Shackley, S. 1997, Alkan Olsson, J. 2003, Ravetz J., 2003.

give unsatisfied stakeholders (groups) a possibility to throw sand into the consensus building process.

One example from the Rönneå studies was the stakeholders identified lack of a strong link between the taken measures and effect in the environment. The considerable time lag between remedy implementation and any visible or even measurable effects in nature became problematic from a stakeholder perspective. One of the strengths of using scenarios is that they are able of turning the clock forwards so that future effects of remedies, as defined in model routines, may be demonstrated at an aggregate scale. But, if no changes can be detected out in "real nature", and the rhythm of political decision-making and policy formulation is too fast, there is a risk that policies that would have been efficient in the long-run may be abandoned too early.

Moreover participatory modelling is a costly and resource demanding activity, both for involved researchers and local stakeholders. Neither the Rönneå catchment dialogues, nor the DEMO-study is any exception to this. Consequently, a major question is whether the cost of participatory modelling makes it a realistic option on a larger scale. Does it produce results that make the costs worthwhile? It is not our ambition to answer this specific question here. Instead we would like to conclude by raising another cluster of points related to our roles as (social) scientist in relation to participatory modelling.

Participatory modelling as critically intervening research

The intention of the WFD can be situated in the context of increased inter-linkage between levels of governance especially visible in relation to environmental management. Several Swedish government commissions have argued that a bottom-up perspective is desirable. In the confusion surrounding the implementation of the WFD in Sweden several bottom-up perspective have been initiated. The DEMO-study is conducted in close collaboration with one of these, the Kaggebo-project. These grass-root initiatives may be resembled to what Isabelle Strengers have described as the utopia of active minorities.[71] These active minorities are able to intervene in the scientific disciplines in new ways based on their own interests. Strengers sees this participation as being able to create new or more complex relations between science and politics, which may create an effective critique towards simple expert-based explications.

If reflecting on this interaction as researcher it is clear that things have become more complex and a new situation has emerged. The questions that remain, however, are how and in which way do we as researchers handle this new situation and can this type of participatory process be a way forward for creating a critically intervening research?

As discussed in previous section any participatory process has effects on the participants which is more long lasting than the actual meeting in it selves moreover the process may also lead to the identification of larger or smaller systematic problems in the structure of existing legal and economic incentives. The dilemma that arises here is if, how and in which way scientists involved in these processes have a responsibility of communicating these issues to for example the decision makers? Which obligations do we have towards our research objects? It is clear that if there are no institutional structures to handle these identified systematic problems and to bring them forward to decision-makers there is a risk of a reversed educational effect and that local stakeholders instead will interpret the whole process as a waist of time. Is there a risk of researchers living in "our own" reality and comfortable "room of action"?

As discussed earlier costly or unpopular measures are less likely to become generally accepted. What about other uneconomic but important measures such as investments in

71 Strengers, I., 1999 p 77–86.

private sewage treatment facilities. Is it possible to create a participatory modelling process around these issues? Which are the risks of researchers being co-opted by local stakeholder interests, and should/could this be avoided? Or may we as researchers be tempted to only engage in processes that are likely to work avoiding inviting stakeholder groups that are unlikely to co-operate?

Another important issue to raise is how participatory is participatory modelling? Does participation give local stakeholders direct influence over political decision-making, and if no, are they (made) aware of this? Through designing and facilitating a participatory modelling process, researchers are able to manipulate the norms and values of participants. Should we do that? Which critical considerations must be raised?

The models and modellers also have a stake in participatory modelling process. Modellers can partly have an interest in that their models earn a good reputation. Several models are commercial products on a competitive market. How could a critical approach on the used model be upheld, without for example risking the inter-disciplinary co-operation between the social scientist and natural scientists involved in this type of projects? Is it possible or necessary within this type of research, and if so, in which way?

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