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Participative and Stakeholder-Based Policy Design, Evaluation and Modeling Processes

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ABSTRACT

The general shift towards a polycentric understanding of policy making requires the involvement of stakeholders as active participants into the policy process at different levels of societal organization. This is particularly true for water resource management where the traditional approach to solving environmental problems with technological fixes and end-of-pipe solutions has started to shift towards a more thoughtful attitude. This involves the development of integrated approaches to problem solving and to include stakeholder perspectives. This tendency receives strong support by the European Water Framework Directive (WFD) that emphasizes an integrated approach to water resources management at basin scale. The WFD requires the inclusion of stakeholders in the process of developing and adopting a river basin management plan. In order to improve stakeholder-based policy design and modeling processes innovation and research is required in linking analytical methods and participatory approaches. Factual knowledge and analytical techniques have to be combined with local knowledge and subjective perceptions of the various stakeholder groups.

Keywords: participatory integrated assessment, agent based modelling, European water framework directive, stakeholder participation.

1. PARTICIPATION AND A NEW UNDERSTANDING OF POLICY MAKING

In the past, water resources management was characterized by clearly defined problems that society wanted solved. The hygienic problems within cities were the reason for major efforts in urban water management. Eutrophication problems in lakes and coastal seas triggered research and legislation. Not all problems have been solved – even in industrialized countries with very high environmental standards like Switzerland. However, the nature of the problems as well as the approach in dealing with them has changed. Traditionally, water resource management was largely shaped by an engineering approach. Technological fixes proved to be very efficient in solving a number of urgent environmental problems, e.g., wastewater treatment and the increasing sophistication of wastewater treatment plants addressing hygienic and pollution problems. Nowadays the situation has changed. Public opinion is shaped by increased environmental awareness and a dissatisfaction with end-of-pipe solutions that are quite resource intensive, sometimes unsatisfactory and increasingly expensive. Environmental problems are more complex and encompass various environmental, economic and social dimensions. One may begin with undefined problem situations rather than clearly defined problems. Often a shared perception of the ''true'' nature of a problem does not exist. An example is given by the diffuse pollution of chemicals where the concentration is below the threshold for showing a major acute and immediately visible effect, e.g., endocrine disrupters.

High levels of uncertainty and the absence of clearly defined cause-effect relationships apply in particular to problems related to sustainability.

Water resources management is facing increasing uncertainties in all areas. Socio-economic boundary conditions change quickly and require more flexible management strategies. Climate change, for example results in an increase in uncertainties, in particular extreme events. Given the fact that current management practices deal with extreme events by designing the technical systems to manage the most extreme of all cases (e.g., higher dams for the protection against extreme floods, larger water reservoirs for droughts and to meet daily peak demand) a serious problem is posed for long-term planning and risk management.

Engineering planning has perceived the human dimension as exogenous boundary conditions. Legislation focused largely on the environmental and technological dimensions

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that set limits and prescribe new technologies without taking the importance of institutional change into account. However, technology is only the ''hardware'' and it is becoming increasingly obvious that the ''software,'' the social dimension, has to become part of planning and management processes. Hence, the inclusion of the human dimension into integrated assessment models and processes will be valuable in supporting the introduction of new elements into planning processes in water resources management. Over the past decade, integrated assessment has emerged as a new discipline that integrates knowledge of an issue and makes it available for decision making processes [1]. In particular, the combination of formal methods and modeling with stakeholder-based, participatory approaches has become an active area of research in integrated assessment over the last years [2]. The experience gathered in this context will also be an important basis for the development of new approaches in water resources management. If decision stakes are high and uncertainty looms large science has to move to its post-normal stage [3]. New management schemes will combine ''hard'' problem solving and decision support techniques based on optimization and factual knowledge with ''soft'' stakeholder-based policy design and application. The development and adoption of new resource regimes will require instances of innovation. In cases of change it is useful to extend the notion of policy making to encompass all levels of systems design. This also implies a polycentric understanding of policy making involving various stakeholder groups and various aspects of social learning. As pointed out repeatedly polycentric governance systems are more flexible and adaptive than mono-centric governance systems [4–6].

Far-reaching institutional reforms are required to foster processes of social learning at various levels of societal organization. In a study for the ''Enquete Commission to the German Bundestag'' institutional reforms of a policy fostering sustainable development were investigated [4]. The authors outlined the following basic societal strategies for institutional reforms:

– reflexivity
– compensation and conflict management
– innovation
– participation and self-organization

This also requires a novel understanding of rationality for sustainability policy and an improved understanding of processes of coordination and cooperation in stakeholder networks, a problem that has been on the research agenda of the social sciences for quite some time.

As early as 1968 Hardin in his famous article entitled ''The Tragedy of the Commons'' [7] described a situation where villagers were using a common field to graze their cattle. The commons tended to be overgrazed since each villager would graze to a point where the private costs equaled the benefits and social costs were neglected. In general, such a situation applies to the problem of 'common pool resources.' And the tragedy of the commons is a typical case of a 'social dilemma' where the maximization of the short-term self-interest of the individual, leaves all participants worse off than feasible alternatives. Each individual faces a trade-off between what is in his or her own short-term interest and what is in the broader interest of the community in which he or she lives. A collective version of social dilemmas occurs frequently in the provision and management of public goods. Nowadays such situations are encountered in all areas of life and may account for the overexploitation and pollution of water resources, arable land or the atmosphere. Hardin's analysis suggested that the only solution to preventing such social dilemmas would be regulation of the commons by a central entity. This would argue in favor of governmental regulation as the most promising strategy for dealing with environmental problems and managing public goods. One possible strategy is the internalization of external costs and the introduction of rigidly controlled management regimes with clear sanctions. However, in her influential book, Elinor Ostrom [8] provided evidence that Hardin's analysis did not apply in general and that local communities have efficient ways of self-organizing and self-governance. Ostrom provided evidence that given homogenous demand for local commodities and services it was possible to prevent the degradation of resources on the base of voluntary co-operation. In more complex multi-scale, multi-commodity resource management problems the interaction between formal and informal institutional settings and between top-down and bottom-up forces should be investigated. Hence, an alternative strategy would explore ways in which governmental intervention and the self-organizing capacity of communities interact and subtly reinforce themselves so as to develop more efficient and enduring resource management regimes. Such an approach could be denominated by a polycentric approach to policy making that begins to characterize an understanding of modern policy in the transformation towards sustainability in general. However, relying only on ''self-organizing'' forces may not be sufficient to realize effective coordination. The question arises how individuals can be motivated to participate in the production of ''collective goods'' that may be defined as new strategies that are shared by a collective of agents, what are the new institutional settings required to achieve coordination. Production of each collective good has to be preceded by an investment of time, effort and even resources by a number of individuals. Such an improved understanding is important to foster processes of social learning which are essential for a polycentric understanding of policy making, for processes of innovation and the adoption of new strategies in heterogeneous actor networks. Processes of social learning are particularly relevant if transformation processes have to be initiated. One can expect that new management regimes will be introduced with the shift in the understanding of policy making

promoted by the European Water Framework Directive where stakeholders have to be actively engaged in defining regional management plans.

2. THE EUROPEAN WATER FRAMEWORK DIRECTIVE (WFD)

Since the release of the new Water Framework Directive (2000/60/EC; WFD) European water policy has entered a new era. The WFD requires public information and participation and encourages the active involvement of all affected parties in the development of the management plan. The WFD introduces the river basin as the management unit, thus following the experience of some European countries (e.g., France ADD and Italy) and the example of the management of some international rivers (e.g., the Rhine). The WFD introduces the development of a River Basin Management Plan, which will cover management options over a period of six years. In particular, users and other stakeholders shall be involved in the production, review and updating of the River Basin Management Plans. Citizens, consumer associations and other non-governmental organizations, as well as economic associations shall be allowed to submit written comments on management plans. The WFD also entails the development of a network of professionals to facilitate the exchange of information and experiences.

The introduction of the river basin as management unit and the coordination of stakeholders and regulatory bodies that operate at sub-basin scales pose considerable challenges to questions of institutional ''fit'' and ''interplay'' [9]. Stakeholders are rarely organized at basin scale which is defined from a topographical/hydrological perspective. The current situation is quite different in the various member states. Germany, for example, is a country where water management is organized around political-administrative units that characterize the multi-level organization of socio-economic systems (municipalities, provinces, states, etc). In particular, considerable efforts in such countries will be required to design a policy process for the successful implementation of basin management authorities. This holds as well for institutional reforms of various types, at various scales.

The WFD supports a new style of policy and decision making which is more open and consultative. It reflects a general shift of EU environmental policy away from a command and control approach towards the use of market based instruments in combination with incentives for self-organization and public participation [10].

On the subject of participation and participatory methods, it is important to point out that stakeholders should not be confused with the public at large. A stakeholder is only defined in reference to a particular issue. Numerous definitions for stakeholders exist. The most appropriate definition may be the one by Glicken [11]: ''A stakeholder is an individual or group influenced by – and with an ability to significantly impact (either directly or indirectly) – the topical area of interest.'' The more tangible a problem and the more long-lasting an issue is on the public agenda, the better defined and organized are stakeholder groups.

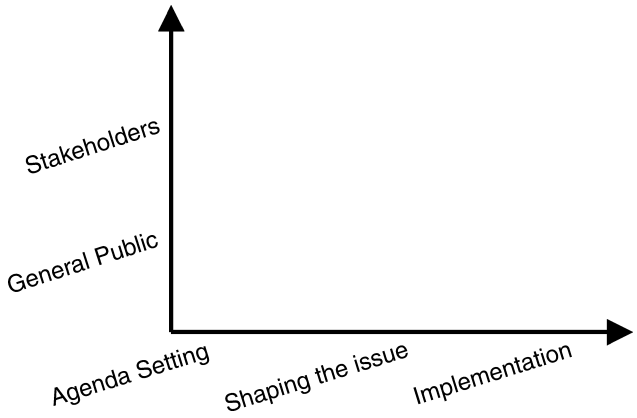

Fig. 1. Scale of participation in the ''life cycle'' of an environmental problem.

Figure 1 characterizes distinctions that can be made with respect to various types of participation along two dimensions: type of participation and the temporal stage of participation.

Dimension referring to type of participation:

1. General public: Citizen participation involving the public at large in issues of general concern – e.g., citizens in their role as voters who have to decide on adopting energy taxes.
2. Stakeholder participation – involving specific stakeholder groups – the various groups are addressed in their specific roles and relative to their stakes in a particular environmental issue – e.g., the inhabitants of an area directly affected by an air pollution problem.

Dimension referring to the temporal stage of participation:

One may involve the general public in various areas of decision making, at different stages in the ''life cycle'' of an environmental problem and, in the development of a management scheme.

– Agenda setting: an early stage of issue definition, as soon as a problem enters the public agenda. The goal of the participatory process here is to map out the diversity of arguments and opinions on the issue. The insights of such a process may guide further research and the development of a strategy to define a management plan. Here processes of what Minsch et al. [4] call participation and self-organization come into play.
– Shaping the issue: developing a plan for resolving the issue, when implementing an integrated river basin

management plan for example. The goal of the participatory process here is to guarantee that the management plan takes the various perspectives into account. Here, the strategies based on reflexivity and innovation, as outlined by Minsch et al. [4], are of importance.
– Implementation: in conflict situations arising from specific issues in relation to the implementation of certain measures. The goal of the participatory process here is to achieve consensus to come with a set of measures that can be realized. Referring again to Minsch et al. [4], compensation and conflict resolution play a vital role.

The water framework directive requires that the river management plan be adopted by the stakeholder involved. The type and methods of participation have not been clearly defined. Given the complexity of the stakeholder network involved in and affected by decision-making processes in this field, the participatory process will include formal relationships – e.g., public authorities who have formal, legal and/or contractual relationships. In particular, it will have to address groups that communicate only informally, or generally do not communicate at all, but who are affected by an integrated management approach.

3. PARTICIPATORY APPROACHES AND VARIOUS METHODS

Public participation, and stakeholder participation in particular have become very popular in resources management over the past few years. Despite this popularity and attempts at widespread application there remain major knowledge gaps in methods and application areas. It would be beyond the scope of this paper to give a comprehensive review on participatory approaches. Here a few methods are introduced as they pertain to the distinctions made in the previous section and the two dimensions outlined in Figure 1.

1. General Public
2. Stakeholder Groups

   A. Agenda Setting – early involvement to define the issues
   B. Shaping the issue – participation in developing a management plan
   C. Implementation – conflict resolution and implementation of specific methods

One important approach for citizen participation is focus groups with citizens, a relatively novel method in the field of integrated environmental assessment. The focus group methodology is widely used in public opinion research and in marketing. Focus groups are designed to expose a group of people to some common stimulus. The stimulus is usually a television speech, a prototype of a new product, or some similar experience. The focus group method has been further developed for Participatory Integrated Assessment [12, 13]. IA-focus groups are group discussions that make use of computer tools to support the discussion and assessment [14, 15]. In general they meet more than once to achieve an in depth discussion of the topic under consideration. The discussions and the social processes in a group are particularly important for the assessment of complex issues where opinion formation plays a major role. The focus group methodology allows to explore in a well-defined setting the range of arguments and perceptions that could arise in the informed public.

The challenges arising from the Water Framework Directive require innovation in participatory methods. Methods that allow, for example, bridging of the spatial misfit with the institutional settings. In Germany for example, legislative and executive authorities rest primarily with the states. Local authorities are responsible for operational functions. At basin scale that is in general across the boundaries of the different states no formal authority exists to date.

Given the current emphasis on the development of integrated models and decision support systems it is particularly important to link participatory processes at an early stage to activities in model building and application. In such a process both the potential users of the decision support systems and all those who are affected by the decisions should be included. To organize such a participatory process should be part of the model building and development work.

Some efforts have been made to develop specific participatory decision-making approaches for water resources management. Hofmann and Mitchell [16] report about the 'RESPECT' model that argues for the importance of research, equity, sustainability, participatory decision making, education, communication and trust. They show for a case study in Canada that the legitimacy of a decision-making process is more important for the decision to be accepted by the general public and the different stakeholder groups than the actual outcome of the decision. This is a confirmation that empowerment warrants more attention due to procedural justice [17], in particular in situations where uncertainties and decision stakes are high. Procedural justice implies that the preferences regarding an outcome of a decision are highly dependent on how the decision was derived. This experience is an argument against developing decision support systems and integrated modeling tools in isolation from stakeholder participation based on the assumption that ''optimal'' decisions can be derived from factual knowledge only. However, it is important that participatory processes have to be matched to the specific cultural and historical context. Vari and Kisgyorgy [18] report for example the first successful attempt in Hungary to involve stakeholders directly in the process of developing water quality legislation and regulation. The project resulted in a number of recommendations for revisions in legislation and initiated a regional water management planning

program. The current institutional setting regarding responsibilities was not changed. Vari and Kisgyorgy conclude that the success of the project confirmed that direct participation of is of key importance in finding feasible and broadly accepted solutions. They further emphasize that in a country like Hungary with virtually no history of cooperation between those who bring new legislation, relevant experts and those affected, stakeholder participation has to be introduced in a stepwise fashion.

The current attempts at developing benchmarking methods for modeling and decision support systems are not valid when issues of stakeholder participation are considered. On one hand, the state of participatory model building and application is still too young and premature a field to start benchmarking efforts. On the other hand, the methods employed in participatory settings depend heavily on the cultural context. Hence, benchmarking could be applied to rules of good practice that allow the development of a specific participatory setting tailored to the historical and cultural context in the different management areas. Currently a major EU-project (HarmoniCOP – Harmonized COllaborative Planning) is in the phase of implementation that will develop the empirical base for a handbook on rules of good practice for stakeholder and public participation in river basin management planning taking into account legal, institutional, and cultural factors.

4. EXAMPLES FOR INNOVATIVE APPROACHES FOR PARTICIPATORY INTEGRATED ASSESSMENT

The European Integrated Assessment community has gathered considerable experience in combining stakeholder participation, formal methods and modeling approaches. The link between citizen participation and Integrated Assessment modeling was explored in a pioneering fashion [12, 13, 19]. In the field of integrated water resources management, there exists an urgent need to apply and develop new methodologies for linking formal, analytical methods and participatory stakeholder based approaches. Given the tradition of water resources management based on technological and physical modeling this will not be an easy task. In addition, conceptual problems wait to be tackled in both modeling and participatory approaches. If one assumes a broad notion of policy making the whole policy process comprises the design of the system with its causal connections and feedback loops, the establishment of resource management regimes including technological and institutional settings, and the design of decision making rules. Successful policy making and the design of new management regimes should be based on a profound understanding of the dynamics of the system. In this respect, the representation of the human dimension encounters certain difficulties and requires distinct improvements both in integrated assessment models and processes. The major difficulties may be summarized as:

- Assumptions about the importance of cooperative versus individualistic strategies differ widely in different approaches.
- The difference between subjectivity versus objective knowledge is often neglected.
- Impact of emotions and the unconscious (Fehr et al. have for example provided evidence that negative emotions are the main driving force for altruistic punishment and cooperative behaviour in experimental settings of the commons pool game).
- The degree to which people can still learn and change their points of view and attitudes is controversial.
- The difference between descriptive (how humans really behave) versus normative (how humans ought to behave) approaches is not always made very explicit.

Agent based models (ABMs) prove to be a very promising approach to including the human dimension into Integrated Assessment modeling in a more realistic fashion (see Moss this volume [20]). Agents, in this context, are autonomous software systems that are intended to describe the behaviour of observed social entities (e.g., individuals, organisations, government agencies). An enormous advantage of agent based modeling is the ability to assess the plausibility of the behaviour of agents, the ways in which the agents interact and the consequences of that behaviour and interaction. The decision process is not perceived as a utility-maximizing choice of (a) single decision maker(s). The latter and more common representations of the nature of decision making and the available policy instruments presuppose a simple system – much more simple than is relevant to the policy issues associated with complex global change problems such as climate change or water scarcity and quality. For one thing, there are the scaling issues. It is widely recognized that most global change phenomena result from the cumulative effect of numerous activities at regional and local scales. At any scale, decisions are actually taken by individuals or as a result of interactions among groups of individuals. And individuals do not finely tune their decisions to maximize happiness on the basis of a belief that they can know everything (and the value of everything) that can possibly happen in the relevant future. Individuals weigh up the evidence of both their own perceptions and information provided by others. This implies a very different decision making process than was presumed in earlier integrated assessment models. These issues can be captured with agent based modeling techniques and participatory model building processes where decision making is perceived as a process of social learning. Agent based models are particularly suited to participatory model building. The potential of new approaches in participatory agent based social simulation and systems analysis of human-technology-environment systems will be presented

for a case study currently being explored in Switzerland. This approach may pave the way for a new approach to water resources management, in particular where major transformation processes towards more sustainable resource management regimes are required. The project is part of the EU-project FIRMA (Freshwater Integrated Resource Management with Agents – http://www.firma) where new approaches in agent based social simulation are developed and applied in five European case studies.

Participatory agent based social simulation deviates in a number of ways from conventional modeling. The actors themselves whose behaviour is represented in the model and who are supposed to later use the models for decision making and strategic planning, participate and contribute to the modeling process. This guarantees that the model captures issues that are of relevance to the actors involved. And the model captures their subjective perceptions and expectations. In any investigation of a system there exist objective components and subjective elements. Decision making is shaped by the perspectives of the decision makers involved. Decision makers have subjective mental models on how the system functions. They base their decisions on their subjective understanding of the world [6, 21]. They have an implicit knowledge about the formal, and in particular the informal rules governing the decision-making processes. Hence, any systems analysis for problem solving has to encompass the human dimension explicitly.

4.1. Social Learning and Demand Management in Switzerland

New approaches for the systems analysis of human environment systems that are tested and implemented in the case study in Switzerland in the area of managing water supply may prove particularly useful for the implementation of the WFD. The new methodology links approaches from hard and soft systems theory (Fig. 2). Stakeholders may change their behaviour and adapt their representation of reality once they are confronted with a model of their system, their reality. This is not trivial from a system theoretic point of view and requires new approaches in our understanding of decision making and of the role of models in such a process.

The first step is the analysis of the stakeholder network in order to be able to design a participatory process and to have a clear base for defining the agent-based model. Approaches from sociological approaches to institutions, institutional economics, and actor network theory need to be combined which is not a trivial task and requires the development of new interdisciplinary approaches in the social sciences. Given our interest in using both subjective categories and theoretical concepts for model development we explored if the categories provided by the analyst match the categories that are used by actors in their mental models of decision making and how the information provided by the

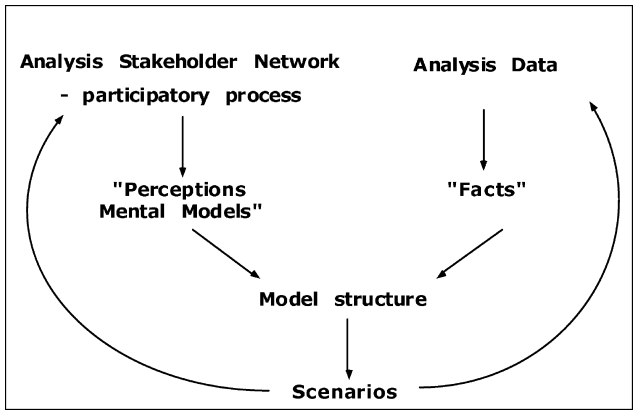

Fig. 2. Combination of ''hard'' and ''soft'' systems methodologies for analyzing stakeholder networks and for participatory model development and application. The development of the model is informed both by methods of analysing data and developing systems categorizations based on abstract notions and by the elicitation of mental models and subjective categories derived from individual stakeholders.

two types of analysis can be combined (Hare & Pahl-Wostl, this volume).

The combination of agent based models and stakeholder participation results in models that allow the linkage of subjective perceptions of individual stakeholders, the knowledge elicited from the stakeholder group and the factual knowledge derived from data. Hence for the development of ABMs various inputs and dimensions of validation are of importance as shown in Figure 3: factual knowledge derived from data, subjective expert knowledge, and mental models. Models also have another role and have to be validated against these dimensions: in terms of how they can explain the factual knowledge derived from data, how they capture implicit expert knowledge and produce results that are plausible to experts, and how they support and foster a process of social learning in a stakeholder group.

Regarding stakeholder participation, the first step is to elicit the implicit knowledge about the system and the formal and informal institutional settings from the stakeholders involved. The second step is to elicit their mental models and invoke them actively in a process of social learning. These steps are now illustrated in more detail for a case study in Switzerland where the water supply system of a major Swiss city was investigated. The engineering rules which provided the basis for building the infrastructure of water-supply systems and the management rules which formed the basis for operating them were elicited from the management board of the water utility, implemented and explored with an agent based model [22–24]. An important management principle is to design capacity to meet daily peak demand. Due to the longevity of infrastructure this results in a highly inflexible system where the legacy of past decisions reflected in high fixed costs may become a burden. This happened when water demand started to decline over

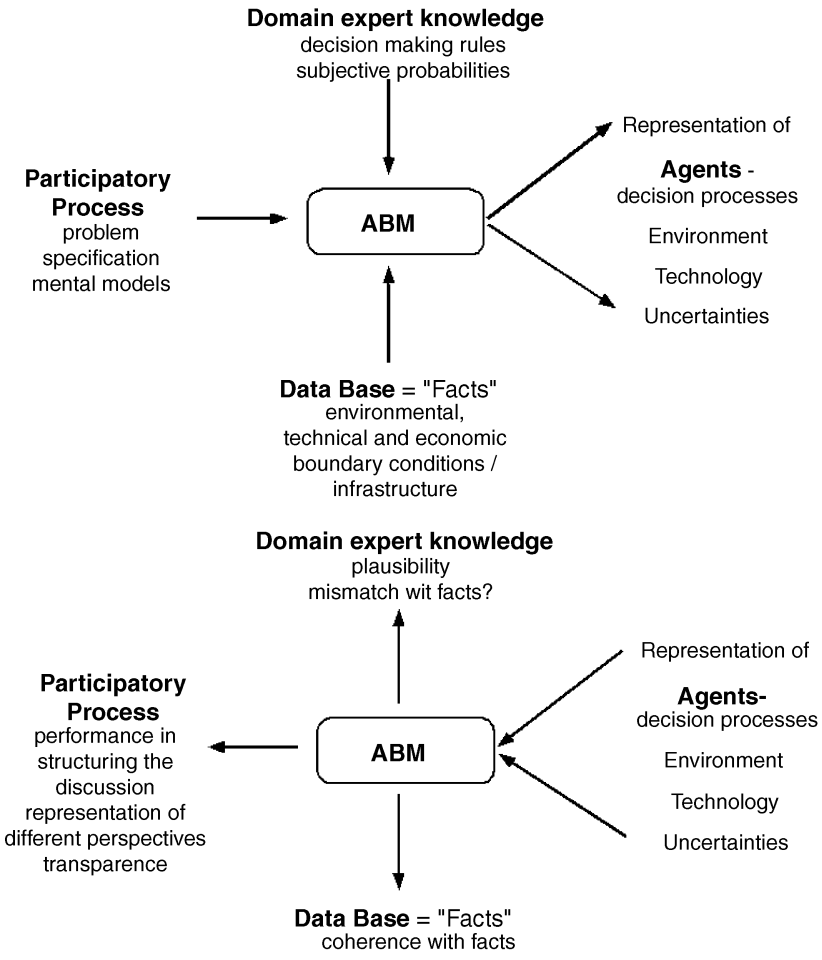

Fig. 3. Dimensions of input into the process of producing (a) and validating (b) an agent-based model within participatory agent based social simulation.

the past two decades after a continuous steady increase over the past century. The rules derived from this served to identify current strategies and to outline possible strategy changes for the future. However, these changes can only be implemented if norms and rule changes are effective in the whole network of stakeholders. Hence, in a second stage the project was expanded to set up an improved participatory process with all stakeholders involved in order to explore paradigm shifts and transformation processes in the stakeholder network (Fig. 4).

After the first stage, where the network of stakeholders relevant for the action system water supply and water saving technologies was analyzed and characterized, we use two different methods for stakeholder participation:

- An actor platform includes representatives from different stakeholder groups, and the participants of the actors platform meet every three months over a period of two to three years.
- Citizen focus groups with about 8 to 10 citizens are currently convened to elicit the preferences of the citizens regarding water saving technologies and the scope for behavioural changes. They will use an ICIT (interactive citizen information tool), and the personal water demand calculator, that allows the exploration of the consequences of choices in life-style and technology on water demand. The individual water demand calculator was designed similar to the individual CO_2 calculator that was applied with much success in citizen focus groups on regional climate change [14]. The citizen focus groups meet only once and are recruited at random. Citizens are involved in their role as stakeholders, consumers and voters.

In summary, the steps of this novel methodology comprise:

- Analysis and representation of stakeholder networks, level and type of organization, scale of activity and institutional settings.
- Design of a participatory process with the stakeholders involved. Establishment of an actors platform with representatives from various stakeholder groups.
- Elicitation of mental models and the development of a shared problem perception. Elicitation of rules governing decision making processes from individual stakeholder groups.

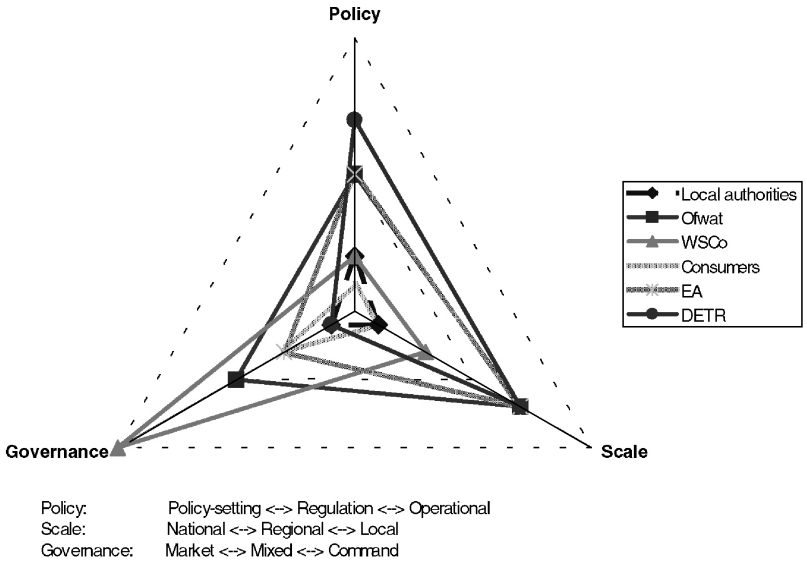

Fig. 4. Stakeholder mapping in the Thames region.

- Development of an agent based model to account for processes of institutional change in the stakeholder network at the scale of the system as a whole (representation of institutional and other actors with a wide sphere of influence).
- If required involvement of specific stakeholder groups in more detail (e.g., consumers by employing focus groups or surveys).
- Extension of the agent based model to a multiscale modular structure where certain processes (e.g., adoption of new technologies, opinion formation in consumer networks) are represented in more detail.
- Participatory model development and application. Elicitation of sets of options for action based on scenarios derived from models.

The approach pursued here shows how a multi-scale participatory process and a multi-scale agent based model can be developed in combination. The model becomes part of and guides the participatory process in the stakeholder group. It proved to be particularly useful to introduce the model in a role playing exercise as a board game into the actors platform (Hare et al., in prep.). Currently we explore the use of the Internet as an additional means for facilitating stakeholder participation [25].

The adoption of river basin management plans will involve complex decision making processes in entire networks of stakeholders. It cannot be expected that institutional settings already exist. Hence, designing a participatory process according to the methodology outlined above will support the establishment of a stakeholder network and the facilitation of processes of social learning. Learning involves the development of a shared understanding of the system under consideration and management objectives, a change of attitudes and mental models and the adoption of new strategies. The scenarios derived from such a participatory modeling process assist in the development of common strategies that are supported by all stakeholders involved. Hence, the combination of both methods offers an interesting approach for supporting processes of negotiation and self-reflection, for facilitating the process of developing ''ownership'' of the models in the stakeholder group. This could imply that a formal authority at a basin scale might be complemented by a more or less formally organized stakeholder network. We consider such processes of social learning to be of prime importance for river basin management, in particular if the introduction of the basin as management scale will lead to the introduction of a new institutional setting, a river basin management authority, that did not previously exist. In such situations issues of institutional fit and interplay become of major relevance [9].

4.2. Scenarios and Demand Management in Southern England

One approach to participatory integrated assessment is to develop scenarios with stakeholders and then analyse key elements of the scenarios with a combination of participatory and model-based techniques. The SIRCH project[1] undertook this approach in the context of institutional responses to climate change in managing the balance of water supply and demand during periods of drought (see Downing et al. [26] for further elaboration of the scenarios and Downing [27] for details of the drought simulation model). The drought of 1995 in England brought water

[1]Social and Institutional Responses to Climate Change and Climatic Hazards: Drought and Floods, EU project contract No. ENV4-CT97 – 0447. See www.eci.ox.ac.uk/sirch for electronic versions of the final report – a journal paper on scenarious is in preparation.

supply and demand management to public attention in an industry that had been privatised in 1989. The drought triggered a change in regulation, with greater emphasis on control of water leakage and demand management, increasingly strict controls on price and investment, and detailed drought planning by water companies and environmental managers.

The steps in the SIRCH process were:

1. Convene a stakeholder panel of water interests in southern England, representing water companies, the economic and environmental regulators, and government.
2. Conduct in-depth interviews regarding climate change, water regulation, drought and demand management in order to build domain expertise in the project and to decide key issues that warrant further evaluation.
3. Produce formal models of relevant issues.
4. Undertake a scenario building exercise with the stakeholder panel.
5. Evaluate the scenarios in a second meeting of the stakeholder panel and using the formal models.

Here, we describe only a few key aspects of the process.

First, stakeholder analysis is not the same as participatory assessment. The main actors in water management in southern England are shown in Figure 4. The stakeholders are mapped on three dimensions. Policy refers to the level of decision making. The government (DETR, now Department for the Environment, Food and Regions) has the highest level of responsibility; consumers generally are not involved in policy setting. The scale of operation spans the national (and some companies are international) to the very local end user. The decision-making environment, governance, ranges from market/profit maximisation to a command economy, with the regulators in between.

Notable in the diagram, is the overlap between the stakeholder ratings, particularly between the Department of the Environment, Ofwat (the economic regulator) and the Environment Agency (EA) – they all have similar frames of reference. In contrast, the water supply companies (WSCo) are at odds with the regulatory bodies. And, the local authorities and consumers have restricted levels of engagement.

This sort of stakeholder characterisation and thematic network analysis underlies the assessment of response

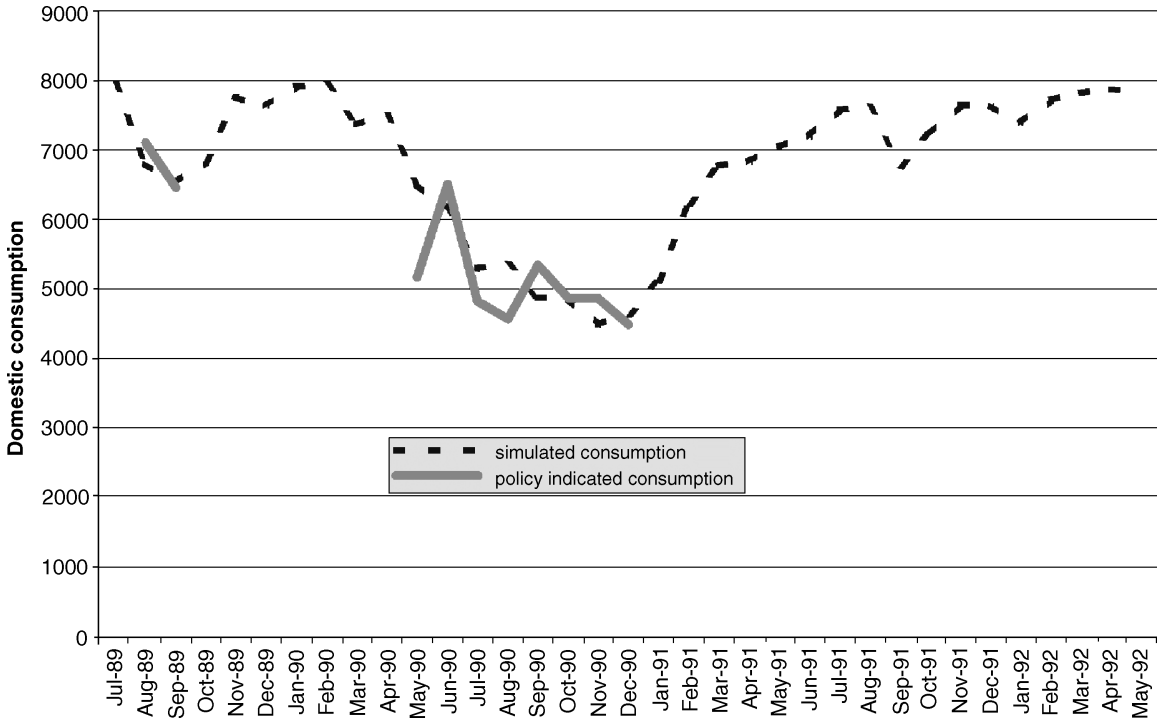

Fig. 5. The figure shows simulated water consumption by domestic households in a region of southern England (dashed line). Consumption varies over the months due to the climatic sensitivity of water use, particularly in summer for watering gardens. When a drought occurs, a policy agent recommends voluntary water conservation (the solid line). Two droughts are shown in the time series, with the summer of 1990 being more prolonged and severe. Households decide on their water use following their own sense of need (related to household size and income), interactions with their neighbours and the policy agent's recommendations. In this simulation, the households respond well to the exhortation to save water. However, at the end of a drought (the cessation of the solid line), consumption only slowly returns to normal. This reflects the delay in policy communication and inertia in behavioural changes by households. While not covering all aspects of water use, the example illustrates the use of an agent-based model to capture interactions within a set of similar agents and between levels of institutional resource management. Source SIRCH project (www.eci.ox.ac.uk/sirch)

opions, including the levels of regulation required to address climate change (e.g., operational, implementation or policy).

Second, participatory scenarios are more insightful than imposed scenarios. The SIRCH panel developed three scenarios, drawing upon a framework established by the UK Foresight Panel and UK Climate Impacts Programme (themselves related to the Intergovernmental Panel on Climate Changes Special Report on Emission Scenarios). The SIRCH project team started the process with two simple themes (a sentence descriptor of the scenario), that were elaborated into storylines (a page of context) and specific indicators (for water supply and demand, for regulation and for stakeholders). The scenarios were:

- *Trend Projection and Conventional Wisdom: The experience of the last 10 years is projected forward, with increased wealth and consumer demand in a mixed regulatory regime.*
- *Economic Growth and Market Enterprise: High economic growth increases wealth, raises expectations, elevates demand for water, increases willingness-to-pay for water-related amenities, and also creates conflicts between water users.*
- *Environmental Stewardship and Regulation: A high general awareness of environmental issues, increased wealth and a more egalitarian society leads to a balance between water use and the environment.*

The scenario process focused on a specific issue – coping with plausible changes in drought risk related to climate change in the context of very different modes of regulation and consumer expectations. The aim of a scenario process is to develop robust insight into the dynamics of an issue. By taking a narrow issue, we could explore relatively extreme scenarios. For instance, in the economic growth case, the environmental regulator has little to do – water required to support environmental goals is purchased in the market by those user communities.

In contrast, two higher level of water scenarios have been developed. The Environment Agency has released a suite of reports adapting the Foresight scenarios for use in projecting plausible supply and demand at the national level. Global water scenarios have been advocated, with the expectation that national planners will find them useful in devising robust master water plans. Such 'imposed' scenarios are difficult to downscale to the complexity of local issues and miss much of the participatory excitement of developing one's own vision of alternative futures.

Third, formal models provide a structure to close dialogue rather than a shortcut to prediction and insight. The language of modelling, essential taken from deterministic systems and natural science, is replete with terms – such as prediction and forecast, simulation and experiment, and optimal and robust – that tend to convey an ability to predict the outcome of human-environment interactions (and to do so on the time scale of climate change). In contrast, social simulation theorists and practitioners recognise model building and evaluation as a means to create a hybrid political ecology in the co-production of knowledge.

The SIRCH project employed three models in the southern England analysis. A game theory model postulated acceptable outcomes between water companies and regulators regarding capital investment and operating expenditure. A classical dynamic simulation model of household water demand and its sensitivity to climate change was used to evaluate the supply/demand balance implied by the three stakeholder scenarios. This model captured the main micro-components of demand (e.g., bathing, washing clothes and watering of the garden), following the industry conventions (called OFV – ownership of water using appliances, frequency of use and volume of water per use).

The dynamic simulation model was extended in an agent-based social simulation platform (SDML) to evaluate how consumers respond to policy exhortations to save water. In this model, a policy agent monitors the supply/demand balance, and if there is a shortage issues a warning to conserve water. Consumers respond, based on their own water requirements and proclivities, knowledge about the public water consumption of their neighbours, and respect for the policy agent. Figure 5 shows a sample of the simulation time series.

For example, in summer 1990, the policy agent recommends reducing consumption, and consumers follow this advice. Indeed, at the end of the drought, it takes a while for consumption to return to the long-term average.

None of the models used captured all of the elements of coping with drought risk. Used with the stakeholder panel, the models stimulated discussion. However, it was often the case that the research team needed to emphasise the difference between the models and reality and that the results should not be taken as specific predictions.

In summary, the SIRCH project developed several useful techniques and demonstrated means to create novel participatory integrated assessments. It did not evaluate the techniques in a rigorous fashion (e.g., the relative benefit to stakeholders of the participatory exercises) nor addressed many of the relevant issues in water risk management in England. Indeed, participatory integrated assessment is an intensive enterprise, in terms of expertise, time and resources.

4.3. Participation in Multi-Criteria Analysis

In other approaches pursued in the development of decision support systems, decision making is perceived as the optimal choice among a set of well-defined options that can be ranked according to objective and quantifiable criteria. These criteria are in general derived from a comprehensive

base of environmental, economic and social data. Even in such approaches it has become common to include stakeholders into decision making processes. A specific decision support system (NAIADE) was developed as an approach where a multi-criteria decision making system was coupled to a stakeholder process to reveal the implications of different subjective valuation schemes [28]. With NAIADE it is possible to assign different dimensions of valuation to a multi-dimensional decision space. For example a monetary quantitative dimension such as the prize of a good can be combined with a qualitative characterization such as few-some-many on a fuzzy scale. This is a first step towards a more integrated approach.

5. CONCLUSIONS AND OUTLOOK

The challenges for integrated water resources management in the advent of the water framework directive can be summarized as:

– Extend the technology driven tradition of water resources management to an integrated management perspective where the human dimension has a prominent place.
– Adopt a new comprehensive notion of policy and polycentric governance that includes the design of flexible and adaptive human-technology-environment systems.
– Bridge the science-policy gap by defining a new role for science as active participant in polycentric policy processes rather than being an external observer.
– Develop new concepts and methods for public and stakeholder participation in multi-scale integrated assessment processes and modeling.

Given these challenges it is evident that the integrated assessment community has an important task to accomplish. The methods outlined in the previous section are based on an understanding of decision making as a process of social learning. Such an approach is based on the idea that water resources management will require instances of innovation and social learning. There are limits to rational, objective analysis that is largely based on a search within a well-defined decision space. Research needs to focus on the dynamics of human – systems on processes of negotiation, coordination and norm changes.

Currently European integration and the development of European governance is an issue of major concern. Recently the European Commission has issued a white paper on governance [29]. In this paper it is emphasized political leaders throughout Europe are facing a real paradox. On the one hand, Europeans want them to find solutions to the major problems confronting our societies. On the other hand, people increasingly distrust institutions and politics or are simply not interested in them. The problem is acknowledged by national parliaments and governments alike. It is particularly acute at the level of the European Union. Many people are losing confidence in a poorly understood and complex system to deliver the policies that they want. The Union is often seen as remote and at the same time too intrusive. No matter how EU policy is prepared and adopted, the way this is done must be more open and easier to follow and understand. The Commission will provide up-to-date, on-line information on preparation of policy through all stages of decision-making.

There needs to be a stronger interaction with regional and local governments and civil society. Member States bear the principal responsibility for achieving this. But the Commission for its part will:

- Establish a more systematic dialogue with representatives of regional and local governments through national and European associations at an early stage in shaping policy.
- Bring greater flexibility into how Community legislation can be implemented in a way which takes account of regional and local conditions.
- Establish and publish minimum standards for consultation on EU policy.
- Establish partnership arrangements going beyond the minimum standards in selected areas committing the Commission to additional consultation in return for more guarantees of the openness and representativity of the organisations consulted.

The framework directive on water has not yet been developed in this spirit. However, its coordinated implementation at regional, national and European levels needs to pay more attention to public participation.

Involving the public is not trivial (Pahl-Wostl, in review). Citizens must have a real stake in an issue to be motivated to actively participate in consultation processes. Their contribution to a topic as complex as river basin management must be based on timely and comprehensive information. The institutional setting must permit the voice of the citizens to be considered in the policy process. The implementation of the WFD provides a good opportunity to promote the idea of European citizenship at a time when European integration is a major theme. However, given the fact that citizens make their choices within quite a narrow perspective and that the idea of European citizenship is not very well developed, major challenges in creating new approaches wait to be tackled.

The European Water Framework Directive is offering a real challenge to the scientific and the policy communities. If the challenge is taken up seriously we will see the advent of a new type of social and policy analysis. The methodological and conceptual innovations outlined in the previous section are examples for approaches currently pursued to achieving such an ambitious goal. Any approaches have to be sensitive to the current institutional settings and the historical development of water resources management in a region. It will be a major task to further develop methodologies that are generic and flexible at the same time.

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