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Abstract

This discussion paper presents the Integrated Methodological Approach for participatory multi-criteria decision support under uncertainty (IMA), which emerged from the debates about participation, multi-criteria analysis (MCA) and benefit-cost analysis (BCA). It provides a framework for participatory and science-based evaluation processes with combined use of BCA and MCA to support large-scale public decisions. While IMA does not claim to realize an all-inclusive participation scheme, it offers the advantage to improve the quality of decision making through advances in *competence* and *fairness*. Its practical application with emphasis on its participatory elements is demonstrated by the case study on the water allocation conflict of the German Spree River, which involves the German capital of Berlin, an important wetland, and the needs to remediate a post-mining landscape.

Keywords: Participation; Multi-criteria analysis; Cost-benefit analysis; River basin management; Integrated Assesement

Introduction: Participation and Multicriteria Evaluation

The traditional way of taking decisions for environmental policy in representative democracies is increasingly considered problematical. Despite the political importance of the subsidiary principle, there is a trend in policy making towards “objective” and aggregating analysis and evaluation methods which de-emphasize the consideration of affected interests and local knowledge. Many affected people do not feel represented by parliamentarians and decision makers such that rejection of decisions increasingly lead to non-violent forms of public resis tance like consumer protests and direct action (Renn et al 1995: 1, Spash 2001: 475). Furthermore, there is the problem of including the interests of affected but voiceless stakeholders – like future generations and non-human beings. This kind of lacking representation in the policy process raises the question of political and ethical legitimacy (O'Neill 2001). In addition to this, environmental administrations often try to resolve environmental problems by means of technologies which require a massive amount of resources and involve a redistribution of wealth. But the knowledge necessary to successfully handle environmental problems is mostly not available and the facts that are known are widely dispersed in society (Press 1994: 1). Under such kind of circumstances with complexities, uncertainties, equity and sustainability issues involved it has been indicated that new forms of participatory environmental decision making are needed.

In face of these problems three very different scientific debates have a prominent stance, all of them concerned with a better practice of environmental decision making and all of them dealing with the issue of participation. One has its roots in the sociological and political sciences. In this debate participatory and deliberative models of democracy are demanded to increase popular sovereignty, political equality and hence to improve the overall legitimacy of the political decision making process (Renn et al. 1995, Coenen et al. 1998). The second debate comes from operational research focusing on multicriteria analysis (MCA) evaluation methods appropriate to support complex decision making by means of mathematical algorithms (Bana e Costa 1990, El-Swaify/Yakowitz 1998, Beinat/Nijkamp 1998). The third debate emerged from economics. Being discontent with the methodological flaws of the benefit-cost analysis (BCA), especially in the field of environmental valuation, some economists tried to overcome some imperfections of BCA by combining it with methods being used by the agents of the other two debates (Munda 1995, Niemeyer/Spash 2001).

In this discussion paper an integrated participatory multicriteria decision support approach, called IMA, is presented that has its roots in the economic debate, but is largely related to both, the MCA and the participation debate. This approach offers a structure to organize a practicable science-based decision support process with participatory elements that aims at increasing the quality in public decision making. The approach is illustrated by a case study on water allocation problems in the Spree River Basin under conditions of global change. While Section 2 of this discussion paper deals in more detail with the three debates about environmental decision support, in Section 3 the IMA method and its rationale will be introduced in general terms. Section 4 presents the application of the participatory elements of the

IMA approach in the cased study. Finally, Section 5 summarizes the findings and draws some conclusions.

Three scientific debates on methods for public environmental decision support

The participation debate

The “Theory of Communicative Action” of the German sociologist Habermas (1988) is one of the major theoretical foundations of the normative debate in the social sciences about public participation as an instrument to improve the democratic basis of decision making. Habermas is concerned that the growing reliance on technological and scientific forms of rationality in policy making reduces public involvement and its potential to include complementary forms of rationality to mere symbolic acts and jeopardizes society accordingly.[1] His remedy to cope with this crisis is to increase citizen involvement in the political sphere through communicative discourse and action. The prerequisites necessary to guarantee an unbiased discourse were formulated in his concept of the ideal speech.

Based on this concept Webler (1995) developed a set of normative criteria and meta-criteria to evaluate the appropriateness and quality of actual citizen participation approaches such as citizens’ juries (Aldred/Jacobs 2000; Crosby 1995), mediation processes (Baughman 1995), stakeholder committees (Beierle/Konisky 2001), consensus conferences (Joss/Durant 1995) and round tables (Belle 1996). Webler considers two meta-criteria as essential: fairness and competence. *Fairness* must be granted to achieve a communicative discourse which enables affected persons to take part and to influence the decision making process. *Competence* is needed to ensure an effective communicative discourse process and to guarantee that present knowledge about the problem at hand is taken into account.

Other authors also refer to additional criteria that cannot be assigned to Webler’s meta-criteria. E.g. Pestman (1998: 196f.) emphasizes the importance of social learning in a participatory process that leads to improved decision making structures in the future. Others have claimed that a better quality of decision making can be defined by improved compliance with environmental rules and laws realized by some form of public involvement (Lemos 1998, Hofman 1998).

[1] Habermas distinguishes four categories of rationality: (1) scientific and technological rationality, (2) the way of thinking utilized in law and morality, (3) the rationality of art and art criticism, and (4) the communicative rationality as the cooperative use of the first three rationalities (Webler 1995: 40 f.).

Beyond the evaluation of participatory approaches, the debate as well encompasses disputes about the characterization of participation approaches (e.g. Arnstein 1969; Kweit/Kweit 1981) and the relationship between participation and expertise (e.g. DeSario/Langton 1987; Wainright 1993). Last but not least, some authors stress the significance of specific cultural, political, technical, and physical circumstances of a participatory decision making process on its quality (e.g. Coenen et al. 1998a,b; White 2001).

All told, independent of the special foci of single authors, they all contribute to a debate about participation as a means to improve the *fairness* of the democratic process through a higher degree of legitimacy, political equality and social learning.

The MCA debate

Contrary to the participation debate the MCA debate does not focus on improving the process of decision making but on upgrading its outcome. It has its general roots in decision theory and focuses on the question of how complex decision situations with many data and a bundle of goals involved can be supported by mathematical or logical algorithms and programming methods (see Pratt et al. 1996). In the past, mathematical tools of multi-criteria analysis have been extensively used for supporting decision making in business and engineering (Schlaifer 1959, 1971). Only recently, a debate started about its use in the sphere of public decisions, especially in environmental management (e.g. Bana e Costa 1990, Roy 1996, El-Swaify/Yakowitz 1998, Beinat/Nijkamp 1998, Coloroni et al. 2001). MCA tools are able to structure complex data sets on alternative actions, to include uncertainty and to reveal correlations and clusters of preferable alternatives. Their key strength is to transform complex data sets into a clear-cut form through a skilful filtering of information. Hence, taking up the wording of the preceding paragraphs, these methods are suited to support the *competence* of decision making.

MCA tools include explicit “subjective” components regarding data selection and aggregation as well as criteria definition and weighting. These subjective elements in MCA are convenient for managers who want to realize individual strategies (Pratt et al. 1996: xv). For taking public decisions, however, an evaluation method that is based on subjective grounds might appear questionable. Nevertheless, considering any evaluation method more closely will reveal that it explicitly or implicitly contains subjective elements – for instance, the discounting of future benefits in BCA. Subjectivity is a characteristic of any evaluation process and therefore the issue is not to avoid it, but to handle it responsibly.

From a scientific point of view there are three alternative ways to deal with subjectivity in MCA evaluation for public decision making. (1) It is possible to reduce the scientific work to that part of decision support that still has a high degree of objectivity, i.e. at least abstaining from criteria selection and weighting, aggregation and final evaluation. This for example can be done with methods like the Hasse-Diagram Technique, which is specialized on pre-structuring of very complex data sets on different alternatives (see e.g. Simon/Brüggemann 2000). (2) It might be argued that in a democratic society with elected representatives, it is legitimate that a single person or a group of decision makers take a final public decision in the name of the public. Under these conditions, scientists who apply MCA methods must use the subjective preferences of the decision makers in their procedure. Furthermore, the MCA process should be made transparent such that it can easily be reconstructed and, if questioned in the political process, justified. (3) With regard to decisions that seriously affect people that are not properly represented in political decision making, the process of applying MCA can be designed in a participatory way. Recently, there emerged a group of MCA scientists designing participatory MCA processes to take the preferences and subjective views of affected stakeholders into account in order to enhance the fairness of the decision process (see e.g. De Marchi et al. 2000, Munda 1995).

Contrary to the sociological debate, the normative element is less pronounced among MCA scientists and there is no claim to realize ideal circumstances of public involvement.

The economic evaluation debate

The third debate on evaluation of alternatives in order to support public decision making originated in economics. Traditionally, economists support public decisions by conducting a BCA. Their largest advantage is the use of only one monetary measure to evaluate the welfare performance of alternative policy options (Hanley/Spash 1993, Garrod/Willis 1999). However, at least three lines of critical arguments are challenging BCA today and are leading to methodological transformations. (1) There is a dispute about the democratic foundations of BCA that leaves people with lower purchase power underrepresented such that participatory approaches are required to improve BCA results (Guha/Martinez-Alier 1997, Niemeyer/Spash 2001, Price 2000). (2) It is argued that BCA has a too narrow focus on the efficiency criterion and neglects important equity and sustainability issues. (3) The measuring of welfare through contingent valuation methods is challenged on methodological and ethical grounds (Munda 1995, Hampicke 1999, Messner 2001). These and other arguments have led to the fact that economists increasingly incorporate MCA and participatory methods into their evaluation efforts to support public decisions. Consequently, economists as well started to tackle the MCA and participation issues described above.

The IMA approach and its participatory elements

IMA stands for **I**ntegrated **M**ethodological **A**pproach for participatory multi-criteria decision support under uncertainty. It is an integrated methodology that combines assessment via BCA, MCA, and participatory elements on the basis of scientific modeling. It provides a generic framework to structure a participatory evaluation process on public decision issues. Being developed as a general concept in a research project on a small-scale water conflict in the Elbe River Basin under the name IANUS (**I**ntegrated **A**ssessment u**N**nder **U**ncertainty for **S**ustainability) (Horsch et al. 2001, Klauer et al. 2001a, 2002), it has been further refined under the name IMA in the GLOWA Elbe project[2] to take the complexities of global change research as well as the participation issue into account (Becker et al. 2001). In its current form IMA is an assessment approach to support public decisions on complex environmental problems in the context of global change affecting many people, large regions and long periods of time, involving considerable social, ecological, and economic effects, and comprising significant uncertainty issues. The major goal of IMA is to improve the quality of environmental decision making in terms of Webler's criteria competence and fairness.

The methodological claim that IMA contributes to an increased *competence* relate to

- the broadening of the knowledge base through participation of stakeholders[3] (C1),
- the inclusion and processing of complex data generated by scientific models into BCA and MCA (C2),
- and to the explicit consideration of uncertainties (C3).

With regard to *fairness* IMA aims at

- including different value and preference systems of affected stakeholders (F1),

[2] The GLOWA Elbe project is financed by the German Ministry of Education and Research and is executing interdisciplinary research on global change and the hydrological cycle of the Elbe River Basin. For further information see: http://www.glowa-elbe.de. or contact the authors.

3 With reference to Coenen et al. (1998b: 308) participation here refers to involvement of affected persons or their representatives into environmental decision making with the purpose of influencing the choices being made. Stakeholders in the context of the IMA approach are defined as affected persons and interest groups involved in a conflict situation and/or in the process to resolve it, without formal decision power. In the following the notion of actors is used to indicate stakeholders *and* decision makers.

- considering the overall concept of sustainability through the inclusion of social, ecological and economic aspects into the analysis (F2), and
- encouraging the participatory process to support the emergence of a widely accepted policy (F3).

In the following description of the IMA approach the above introduced abbreviations (C1, F1 etc.) will be used to refer to these competence and fairness attributes without discussing it in detail.

IMA can be described by a sequence of four major steps, being

- *first*, problem analysis and scenario derivation,
- *second*, indicator and criteria selection,
- *third*, impact analysis via modeling or other effect estimation methods, and
- *fourth*, evaluation using BCA and MCA.

Although, this or a similar sequence of steps is indeed indispensable for any evaluation methodology (see e.g. for AHP Forman 1990 and Belton/Vickers 1990 and for BCA Hanley/Spash 1993: 8 ff.), the uniqueness of IMA arises from its specific characteristics. IMA encompasses the claim to consider uncertainties explicitly (competenceC3), to combine benefit-cost and multicriteria analysis, and to enhance the significance of participation in order to improve the fairness (F1-3) as well as the competence (C1) of the decision process. Since the focus of this article is on participation the four IMA steps are presented in more detail in the following with a special emphasis on its participatory elements that are crucial to improve competence and fairness in decision making.

Step 1: Problem analysis and scenario derivation

The starting point in Step 1 is a thorough problem analysis comprising the examination of the conflict and the institutional setting that exists to resolve it. Literature and documents are studied to realize the history of the problem, the parties involved, the decision making structure to resolve the conflict and the measures already taken. This analysis is complemented later on by a stakeholder analysis. Using semi-structured qualitative interviews, actors involved in the conflict – i.e. stakeholders as well as decision makers and their executive authorities – are asked to describe their perception of the conflict and their view on how the problem could or should be resolved. This way a more comprehensive picture with a multitude of perspectives emerges: actors and information not mentioned in the literature can be revealed during interviews, informal relationships among actors and informal structures within the policy making process can be uncovered and local knowledge as well as internal data from authorities and enterprises becomes available to the researchers (C1). Since in the stakeholder analysis proposals to resolve the problem are surveyed as well, it serves as a means to bridge the initial problem analysis and the following analysis to derive scenarios.

By definition a *scenario* within the IMA methodology comprises two elements: a *policy alternative* and a *framework of development* (see Messner et al. 2001). A policy alternative is considered to be a combination of single policy options that can be realized in different fields of action.[4] To ask stakeholders in qualitative interviews which fields of action, policy options and policy alternatives they deem to be relevant for the resolution of the problem is part of the stakeholder analysis. All relevant answers of the interviewees are gathered in order to get a comprehensive possibility space of policy alternatives. This way no major pre-decisions ─ such as the exclusion of policy options ─ occur in this early stage (C1, F1). Of course, policy proposals can also be proposed by the scientists. A *framework of development* contains external future development conditions that can not be influenced by individual regional actors but that might have a significant impact on policy outcomes, like the pattern of economic development, trends in climate change etc. For the assessment of policy alternatives several frameworks of development must be considered. They are important to reflect the uncertainty about future development, because for the success of a policy alternative it is decisive how it will perform under different future conditions. The assumptions about different frameworks of development are defined by the scientists in cooperation with experts, decision makers, and stakeholders (C1, C3). At the end of step 1 a set of scenarios is available that has been derived together with decision makers and stakeholders. This way the assessment of policy alternatives to resolve a regional problem in a participatory context has been put on a solid basis.

Step 2: Selection of evaluation indicators and criteria

What is regarded success and failure is essential for the assessment of policy alternatives. Therefore, in a consecutive stage of the interviews the actors are asked to specify the indicators they would like to use to measure and assess scenario effects. In order to prevent disputes among stakeholders and as a matter of fairness, all indicators stated to be important should be included in the assessment process (F1) ─ provided double-counting of effects does not occur and it is feasible to estimate data for them in step 3. As far as the actors accept the general

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[4] For instance, the regulation of water quantity in a river is a *field of action*, the many measures possible to influence water allocation are *policy options*, and the combination of single options of one or several fields of action – e.g. building a dam *and* a pipeline – is called a *policy alternative*.

policy aim of sustainable development, the inclusion of ecological, social, and economic indicators should be ensured (F2).[5] Later on, evaluation criteria must be defined, i.e. evaluation schemes must be derived for every indicator or group of indicators (Klauer et al. 2001b). For example, if stakeholders want to measure and assess water quality in terms of nitrate concentration, it must be decided, among others, which concentration is acceptable or which degree of spatial and time aggregation is adequate (e.g. one could choose *one* average value over space and time or a *multitude* of specific nitrate concentrations for different locations and time periods). Since the choice of indicators and criteria already contain value decisions, this should be done together with stakeholders and decision makers (F1).

Step 3: Modeling and Estimation of Scenario Effects

The third step of IMA involves the scientific modeling and estimation of scenario effects with results in terms of indicator data as defined in step 2. Very different scientific models but also estimations of practical experts and actors can be used in the context of IMA, depending on the indicators chosen (Horsch et al. 2001, ch. 2; Becker et al. 2001). A special requirement in this step is the explicit inclusion of information about the uncertainties linked to the models and data used and the consideration of future uncertainties. The modelers are requested to deliver not only data on scenario results, but also on the probability of results and the possible range of model failures. Both are taken into account within the MCA assessment process later on (Klauer et al. 2002). E.g., in the case study, the hydrological model was fed with one hundred variants of one climate scenario in order to deliver the probability distribution connected to the climate uncertainty that water will be available at specific locations in the future (C3). In this step participation is limited to the general discussion of models and their assumptions and to data support by experts or stakeholders to adjust models to local conditions.

Step 4: Assessment

The fourth step deals with MCA and is divided into two parts: a preparatory mono-criteria and a final multi-criteria assessment. The mono-criteria assessment evaluates the alternatives with respect to each single criterion selected in step 2. In the context of IMA benefit-cost analysis plays a major role. As a rationale of assessment, many effects are evaluated in economic welfare terms – as far as monetary evaluation is feasible, is based on reliable data and

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[5] In the context of the IMA approach the so-called three column approach to sustainable development is applied, i.e. a development is to be ensured that takes basic social, ecological and economic needs for current and future generations into account (Enquete Commission 1998).

accepted by decision makers and stakeholders. An advantage of using BCA in the context of MCA refers to the fact that the aggregation of monetized effects that are incommensurable in character (e.g. due to equity reasons) need not be done, i.e. the BCA approach may feed several results into the MCA. All effects that cannot be expressed in monetary terms due to methodological problems are assessed by other quantitative or qualitative criteria, using specific and sometimes very complex model-based evaluation techniques (e.g. to assess nitrate concentration in groundwater or increased risk for red list species). The results of all mono-criteria assessments enter the MCA process in form of a multicriteria matrix for every future frame of development defined in Step 1. The participants of this process should be selected in a way that all kinds of interests are represented (F1). After having explained and discussed the results and their implications, the stakeholders and decision makers are asked to assign weights to the criteria. Using an outranking approach – for instance "extended PROMETHEE" (Klauer et al. 2002) – rankings of alternatives are calculated for all participants and these results are subject to discussion. Most probably it will be found that some policy alternatives do perform very differently using different weights or different frames of development. Therefore, it is the aim of the discussion to find a widely accepted compromise for a weighting scheme or a common risk behavior in face of different future developments (F3). As a result, one or a group of alternatives should be identified to be the most advantageous. If it is found that none of the alternatives is performing well and some additional alternatives should be considered, an iterative process starts in IMA to take new alternatives into account. Proceeding this way, MCA is not used to calculate an optimal policy alternative, but to structure the problem and the results, to reveal the uncertainties involved, and to feed reliable information as an input into the participatory discourse (C2).

Application of IMA in the water allocation conflict of the Spree River Basin

The water allocation conflict

In the Spree River Basin, which is located in the East German Lusatia region, a water quantity problem arose in recent years due to lignite mining. Since the early 20th century large-scale open pit lignite mining was practiced with production up to 220 million tons in 1989. Extracting one ton of lignite requires pumping six tons of groundwater, so more than 1 billion cubicmeters per year were pumped into the Spree River and other regional streams (Grünewald 1996). This way a relatively dry region with precipitation of about 550-600 mm per annum changed into a water abundant region. Consequently, economic water uses began to increase, the Spreewald wetland area could evolve better and the capital city of Berlin did not experience problems with water supply. However, things changed drastically after German reunification in 1990 when many unprofitable mines were closed such that 75% less water was pumped into the rivers. Moreover, the restoration of mining pits requires massive amounts of water to fill the pits, to reconstitute the groundwater level and to create a new lake landscape. Simultaneously, the infiltration losses in the river network caused by groundwater depression were decreasing slowly. Hence, during the winding up of mining pits less and less water was available for water users downstream. A variety of water users located in three different German states (Saxony, Brandenburg, Berlin) had to fear that they would loose off in the dispute over water allocation. In this context, at least two lines of conflict can be characterized. (1) The traditional water users (energy production, inland fisheries, inland navigation, tourism at reservoirs and wetland) wanted to defend their traditional water rights against the upcoming claims of the new water users (mining restoration and tourism at mining lakes). (2) Since water allocation is an issue to be decided legally within the states, water users within each state and the state administrations were interested in keeping the water in their state to secure an undisturbed economic development. Consequently, a typical upstream-downstream conflict arose, involving administration and water users of three states.

Initial setting of conflict resolution and participation

After several years of dispute between the state authorities it was agreed to establish a cross-state working group in 1998 to find a compromise solution. In this working group representatives of the water, mining and environmental authorities of all three states were included. Furthermore, the large water users of the energy, mining and restoration industries were represented. To represent all other water users the administration founded the Lusatia Initiative in 2000. This is a community of interests of small water users which takes part in the working group with one representative. Based on the expertise of hydrologists and their scientific models the cross-state working group tried to find a compromise solution. They finally agreed upon a common water management strategy in 2000 that included four major measures. (1) It was agreed to secure the water rights of the traditional water users by giving them a higher priority in water allocation than to the new water demand for restoration and tourism. (2) Reduce the water flow level thresholds in the Spree River at specific user points (e.g. from 12 to 8 m^3/sec for inflow to Berlin). (3) Establish a water management control system to optimize water use in the basin founded on computer-based water management. (4) Build a water pipeline to pump water from the neighboring Neiße River basin into the Spree River (LIWAG 2001). By applying these measures the water problems were thought to have largely been solved in the region. However, in the hydrological modeling future uncertainties like global change trends were not taken into account. At the same time, there are already clear indications today that despite the compromise management strategy the water demand of important water users like Berlin and the inland fisheries could not be met in recent years.

Dealing with the risks of participation in research projects

The presented case study was carried out in the research project "Global Change and the Hydrological Cycle in the Elbe River Basin (GLOWA Elbe)". The issues of socio-economic and climatic global change and its impacts on water availability of the Spree River Basin up to 2052 were major topics of research. The German ministry of education and research, which funded this project, demanded problem-oriented and applied research as well as stakeholder involvement to analyze and tackle the conflict. Hence, it was planned to use the participatory IMA approach. While the chances of participation are widely acknowledged, the risks of participation are neglected in the debate.

Right from the start it was evident that participation of affected parties and decision makers as an integral part of a scientific project might engender difficulties. For instance, the decision makers could reject the further involvement of additional stakeholders; affected parties could reject participation due to limited power; participation of too many stakeholders could be ineffective; the democratic purpose of participation may be undermined by dominant and eloquent speakers (see Webler/Renn 1995). Furthermore, the scientific assessment tools like BCA and MCA used to support the decision making process could also be rejected by the participants. They could be considered too technical with a black-box character, too strange compared to the traditional instruments of decision making or too remote from every-day rationality.

Thus, choosing to include participation and applied scientific decision support as key elements in a research project was promising in terms of applied research, but also meant the inclusion of the risk of failure with the scientific project in central parts. Considering the situation in the Spree River Basin conflict, this risk was minor, because the decision makers had already started a participatory approach themselves and they were also relying on technical algorithms of water management models in their decision making. Therefore, applying IMA in this context seemed to be feasible. Nevertheless, in the planning stage of the GLOWA Elbe project a hierarchy of project objectives was formulated in order to avoid project failure due to the risks of participation and applied decision support:

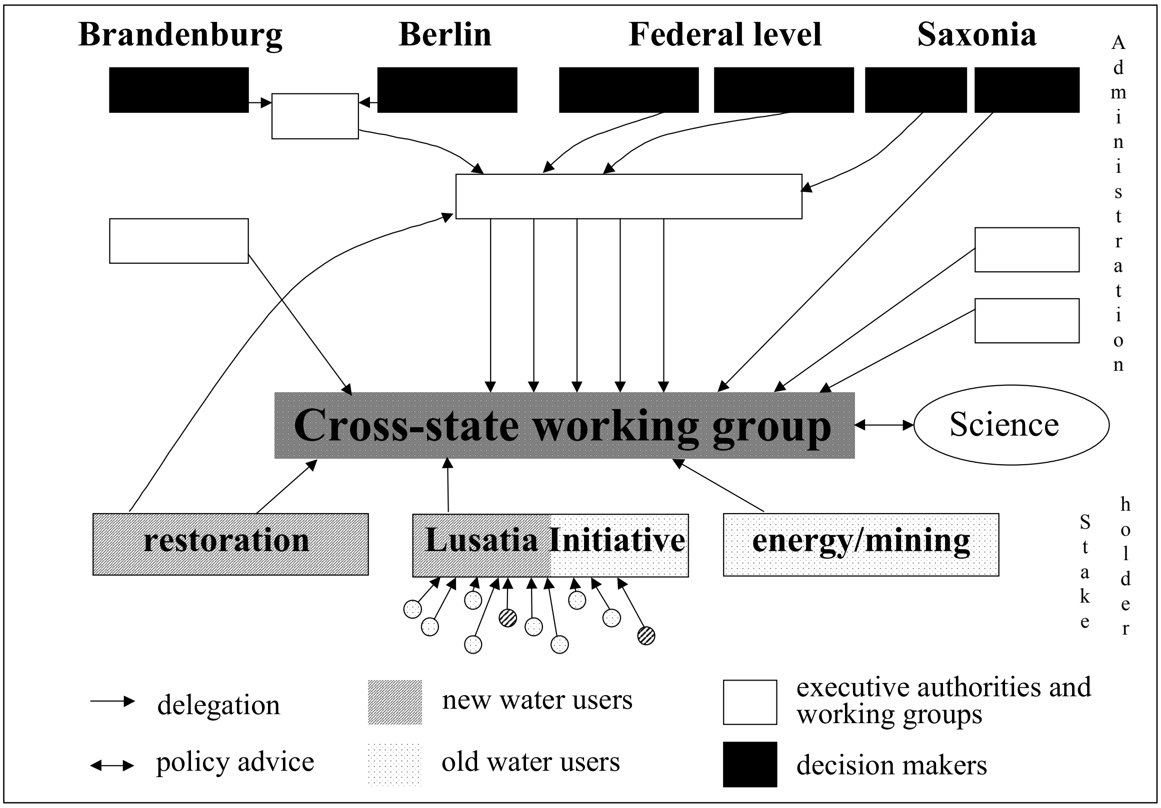
1. Main research focus on interdisciplinary problem-oriented research on impacts of global change (ensuring minimum scientific success, limiting participation to informing, talking and listening to stakeholders and decision makers).
2. Major utilization of research results to support the decision making process of the cross-state working group with modeling assessment tools (ensuring enlarged decision competence through scientific support even without direct involvement of further stakeholders).
3. Distinct efforts to realize a higher degree of participation in the decision process (to ensure the involvement of key stakeholders in order to improve in fairness issues).

Proceeding this way guaranteed a minimum success of the research project which was not entirely dependent on the pitfalls of participation (no. 1), while applied research in the form of decision support (no. 2) and stakeholder involvement (no. 3) are not excluded – but considered as objectives with minor priority. In this way we dealt with a very special participation problem: the participation of science in the decision process.

IMA-Steps 1 and 2: stakeholder analysis and participation in scenario and indicator derivation

Following a literature study a first group of decision makers, personnel from state authorities and representatives of affected water users were interviewed to get a better understanding of the Spree River water conflict. In a second bundle of interviews additional stakeholders were included that were mentioned in former interviews and this kind of snow ball system made it possible to obtain a comprehensive list of important stakeholders and decision makers involved in the conflict. After the interviews three types of stakeholders were distinguished: first, decision makers from the ministries and their scientific advisors; second, personnel from state authorities including water and mining experts; and third, important water users which are affected by the reduced water amounts in the Rivers. This group encompassed representatives of inland fishery companies, the energy and the mining corporation, water utilities, the state owned restoration company, the farmer and tourism associations and majors of small cities near the Spree River. Summing up the interpretations of 20 interviews with 25 interviewees, four groups of results must be mentioned.

(1) The analysis of interviews engendered detailed knowledge about the complexities of the conflict and the existing governance structure to deal with it. Figure 1 shows schematically the interaction of water users, decision makers and executive authorities of three German states that all have different degrees of power to influence, prepare and execute decisions. The reconciling element is the participatory cross-state working group. Although not all interests were equally represented in this group, it was decided in the GLOWA Elbe project to build upon its past achievements. Therefore, the scientists started the decision supporting group talks with this group, which already was able to find a first compromise water management strategy (F1).



(2) Talking with the stakeholders about their ideas of resolving the conflicts, three fields of action could be identified: optimizing water use in the region, drawing additional water from other basins, and altering water allocation priorities. All policy options and further ideas were collected as a knowledge input for further discussion in group talks later on (C1). Since not all interviewees could be invited to the group talks, they at least all contributed to the general knowledge pool through the interview process (F1).

(3) Being asked about their view on the impact of global change on the water allocation conflict, most decision makers and stakeholders did not relate these two issues. After ex

plaining to them the probable effects of climate change, economic liberalisation and population development on water availability and the way the IMA method takes these uncertainties into account, most interviewees welcomed the broadening of the information base through scientific analysis (C1, C2, C3).

(4) In the discussion about evaluation indicators and criteria all interviewees contributed to the bundle of indicators deemed to be important. These included water quality indicators, water availability and distribution indicators, economic impacts of reduced water availability, employment in the region and ecological impacts on natural landscapes (F1, F2).

Starting the participation process with individual interviews proved to be successful. In addition to the information that has been collected, the interview situations with questions regarding the opinion of single actors generated a relation of trust which was a solid basis for the following process.

Formulating scenarios for the context of global change in group talks after step 3

After the interpretation of interview results and after completing scientific modeling of global change effects on water availability a first stakeholder group talk was initiated with members of the cross-state working group. The modeling results with the water management model ArcGRM (Grünewald et al. 2001) were presented, which reflected probable variations of regional climate change. These results revealed that despite the execution of the current water management strategy, further water availability reductions are to be expected in the future under global change conditions (C1, C2, C3). In the following discussion the attending actors talked about complementary measures to deal with this situation, while additional information was introduced by scientists from the knowledge pool of the interviews. In the course of the debate it turned out that several policy options were possible. First, *drawing additional water from the Oder River* had been discussed early but was believed either too expensive or too problematical in terms of water quality (in short: Oder transition option). Second, it was proposed to *reduce the pumping of mining water into smaller streams* to maintain ecological standards until a self-regulated hydrological balance will be achieved (in short: reduced stream option). Third, the discourse turned to the possibility *to reduce water rights of traditional users and to compensate them accordingly* in favor of accelerated restoration of old mining pits (in short: filling option). Since some of these policy options were called taboo options in some interviews, it was encouraging that these options were now openly proposed for further analysis. Thus, the decision space was opened up in the participation process.

IMA Step 4: designing participation for the final assessment

Since the modeling results and the mono-criteria evaluations are not completed yet, the final step of IMA is still in a planning stage. However, referring to the plans, the final phase will be organized as follows. Based upon the scenarios developed in the group talk the scientists started with impact analyses. This includes the scientific derivation of proposals for evaluation criteria based on the participants' indicator list. While time is needed to execute modeling and preparatory mono-criteria evaluation, the stakeholders of the cross-state working group will be visited individually to discuss the criteria and to weight them. Moreover, additional stakeholders are selected for participating in the following group talk based upon the degree of being affected by water scarcity according to the modeling results. Since the potential new participants have been interviewed before, they will be informed about the actual state of the process and asked to give criteria weightings as well. After the completion of modeling and the impact matrix the MCA evaluation starts. Using the criteria weightings of the stakeholders, a policy alternative ranking is calculated for every stakeholder for all frames of development. In order to structure the heterogeneous ranking results two kinds of ordering tools will be applied. First, a *trade-off analysis* will be executed to analyze the similarity and dissimilarities of preferences. Second, in a *future-uncertainty analysis* the sensitivity of the scenario rankings is examined with reference to different frames of future development. These results will be used later on in the following group talk (F3).

Eventually, selected members of the cross-state working group and additional stakeholders are invited for the participatory assessment group talk. This talk will be organized in two blocks. In the first bloc modeling results for all scenarios and mono-criteria evaluations and their implications are presented and discussed with the participants. In the second bloc the individual preferences and the scenario ranking results of the MCA are presented and interpreted using the outcomes of the trade-off and future-uncertainty analyses. In this way, every stakeholder or stakeholder group gets a voice that is heard in the participation process and this voice should generate awareness about the situation of the respective participant. In the following discourse it will be checked whether a common weighting scheme for the criteria and a common attitude towards future risk is achievable. The course of this debate deeply depends on the degree of heterogeneity of results, on group dynamics and on the degree of discourse competence and fairness being practiced among participants. Perhaps a common or a large majority attitude can be identified that indicates at one policy alternative being the most advantageous. Otherwise, the moderator will try to focus the discussion on the formulation of new compromise policy alternative. In this case, the IMA steps 3 (modeling) and 4 (evaluation) will be repeated.

The outcome of the Spree River Basin case study is still uncertain. Probably, several sessions will be necessary to finally agree upon a compromise policy. But even if a common strategy will not be found and the decision makers will decide in the end against an opposing stakeholder group, the mere application of the IMA process will have produced a better awareness of future uncertainties and stakeholders concerns. Thus, the basis of the decision will be much less myopic and narrow than it would have been otherwise.

Summary and conclusion

In this paper the IMA approach and its practical application in the Spree River case study have been presented. IMA provides a methodological structure for a science-based decision support with participatory elements that is suited to support complex environmental decisions with many people and large areas involved. Methodologically IMA has it roots in three different scientific debates concerned with improving the quality of environmental decision making: the participation, the MCA, and the economic BCA debate. Without doubt, IMA cannot comply with the ideal claims required by Webler (1995) in the participation debate. There are clear deficiencies, e.g. regarding the incorporation of all affected stakeholders, the common selection of discourse rules and scientific methods used. Nevertheless, there are at least six features of IMA related to two meta-criteria that have the potential to contribute to improvements in environmental decision making. On the one hand, the IMA approach improves the *competence* of the decision process through incorporating and structuring additional information including uncertainty and through offering MCA tools able to promote a convergence in the decision making process (C1, C2, C3). On the other hand, it enriches the decision process in terms of *fairness*. It includes the views and interests of many affected stakeholders early in the process and opens up the possibility space of problem solutions. Furthermore, it strives for the treatment of sustainability issues and feeds helpful information into the participatory discourse in order to promote the emergence of a widely accepted policy (F1, F2, F3). Unfortunately, applying the IMA approach is neither cheap nor quick. For the described case study it took a budget of about one million Euro, but for other cases the exact figure depends on the models and evaluation methods used. However, if decisions on complex problems on a large time and spatial scale with a number of uncertainty issues are required – as is currently the case in expanding EU-Europe regarding river basin management – IMA can help and the investment in decision support may pay.

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