# A tool for multi-stakeholder participation

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## Abstract

Decisions regarding water management issues are by nature complex; they involve balancing the three interconnected pillars of sustainability: social welfare, economic needs and the needs of an ever-changing environment. Moreover, such decisions may include controversial or poorly understood issues, such as the role of equity or property rights, as well as conflicts of interest. Due to the uncertainty about the facts of the matter or simply due to differences in goals, different stakeholders (people or interest groups that are directly affected by or affecting a management problem) will often have quite different perspectives on what should be done. Only by taking into account these different perspectives and trying to balance the needs of society, environment and economics, can a manager reach any type of sustainable decision: one that will be generally acceptable and beneficial to all sectors.

Sharing perspectives, i.e. finding a group consensus on weights and scores before entering them into the model is an ambitious goal but sometimes not feasible in conflicting situations. We need tools able to incorporate inputs from different people in order to compare and aggregate different perspectives. Thus, we aim to support stakeholders in making just such a complex decision.

We can start off the process by stating that the goals of such a tool include

- solutions to problems of resources use.
- solutions that are generally acceptable (for which there is a consensus amongst participants,
- solutions that can be financed
- solutions that are relevant worldwide and thus adaptable to other regions
- solutions that can be carried out within timelines appropriate to the length of a project
- sustainable solutions.

We suggest a methodological approach supported by the software tool called, *AquaDT,* that facilitates the process of decision making when adaptive, participatory and multi-level management arrangements have been or are likely to be critical to success.

*Keywords: multi stakeholder approaches, participation, water resources management, multicriteria tools, web-based tools, consensus building*

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# 1 Introduction

Single solutions to complex problems are just a dream if not a nightmare. There is often no single solution that can be attached to complex problems of managing water resources. Adaptive Management (AM) is a proper management approach that includes the particularities of complex systems. AM originates from the recognition that natural systems and the interactions between people and ecosystems are unpredictable (Gunderson, Holling, & Light, 1995). AM incorporates design, management and monitoring to systematically investigate statements in order to adapt and learn. Learning-by-doing, learning-by-observing, learning by copying are key principles underlying AM.

Already in the seventies, the notion of learning within action groups was best described as "social learning". Bandura (1977) explained social learning as the continuous reciprocal interaction between cognitive, behavioural and environmental influences. "Social learning refers to the process by which changes in the social condition occur –particularly changes in popular awareness and changes in how individuals see their private interests linked with the shared interests of their fellow citizens. This is a product of individuals learning how to solve their shared problems in a manner that is responsible to both, factual correctness and normative consent (meaning legal and social responsibilities". Within AM, social learning draws the attention towards processes through which the "capacity of authorities, experts, interest groups and the general public to manage their river basins effectively" is increased (Webler, Kastenholz, & Renn, 1995). Such a process can take several forms, e.g.: learning to understand that all actors are empowered in the same way, learning other actors strategies of solving conflicts or learning ways of managing that have been developed together through the process of exchange (Borowski, 2004) .

AM has been described as an integrated, multidisciplinary and systematic approach to improving management and accommodating change by learning from the outcomes of management policies and practices (Holling, 1978). In other words, AM involves the design and implementation of management programs that offer the possibility to experiment with and compare selected policies and practices. This comparison takes place through evaluation of alternative hypotheses about the system (Holling (1978); Walters (1997); Lee (1999)). Lee (1993) emphasises the usefulness of this approach by stating: if human understanding of nature is imperfect, then human interactions with nature should be experimental. Hypotheses and assumptions are developed based on a thorough understanding of the system as a way to anticipate possibilities and uncertainties that could have an impact on the system. These hypotheses and assumptions are translated into plans and actions which are evaluated and monitored in order to test their effect on the system. Based on these results, the hypothesis and assumptions will be adapted with the objective to improve the overall management framework. The idea is that this process is repeated to guarantee continuous improvement. Advantages that are claimed for AM include: (a) increasing the pace and frequency at which policy makers and resource managers acquire knowledge about ecological relationships; (b) aiding management decisions through the use of iterative hypothesis testing; (c) enhancing information flows among policy makers; (d) creating shared understanding among scientists, policy makers, and managers (McLain & Lee (1996), Wondoleck & Yaffee (2000) and McDaniels & Gregory (2004)).

# 2 A tool for adaptive management: *AquaDT*.

The strengthening of conceptual foundations for AM approaches and the creation of tools are critical points within the relatively new development of policy instruments and theory for AM. Sagoff (2004) calls for the increased use of stakeholder negotiations in the design and implementation of environmental policies. Already 1985 Roy emphasized that the aim of tools used in such negotiation processes is not to find a solution, but to build and generate a set of relations amongst actions that inform the actors taking part in the decision process.

Our contribution to developing tools for adaptive management is the development of *AquaDT*, a multicriteria decision support tool (MCDA) created within the frame of the European project AquaStress. The tool has been constructed in collaboration between the Environmental & Energy Management Research Unit (EEMRU) of the National Technical University of Athens and the Environmental Resources Flow Unit (SSM) at University of Osnabrück. With *AquaDT* we shaped a way of improving and supporting deliberation processes within complex problems in order to develop adaptive management strategies. *AquaDT* aims at structuring the deliberation and at affecting the nature of mental processes and the type of substantive outputs delivered (comp. Kallis, 192, 2006). Accordingly, *AquaDT* is more a process-tool that an outputs-tool. It structures the deliberation process, assisting on: framing, scoping, generation and finally evaluation and comparison of alternatives. It enables people to think about their values and preferences from several points of views through communication about problem definition, the setup of alternatives, and criteria (comp. Refsgaard, 194, 2006). Thus, it promotes social learning processes between participants, allows for analysing conflicts and supports "feedback loops" in the planning process.

Additionally through the use of *AquaDT* we can achieve the request of the article 14 of the Water Framework Directive and its demand for involving relevant social actors in the water governance processes, taking into account the plurality of interests, the differing views, the different values and the relationships with and within water management.

*AquaDT* as a MCDA tool is appropriate for decisions related to complex systems, where diverse stakeholders are in conflict and/or where relationships and feedbacks between different parts of the ecosystem and the economy exist. MCDA is an effective technique with which to identify trade-offs in the decision-making process, with the ultimate goal of achieving compromise. MCDA provides an approach that links valuation and deliberation without assuming that values can be reduced to monetary terms (Proctor and Drechsler 2006, 172).

Stagl (2004) affirms that the theoretical foundations for MCDA supporting a deliberative democracy are still weak. She added that this should not be a reason for remaining away from experimenting with them, but rather lead to a co-evolutionary development of theories and methods. This attempt involves significant efforts to build bridges between scientific disciplines.

> "In learning processes in general stakeholders try to understand and explain the societal phenomena, which we observe, but also to bring about personal liberation and social transformation. In this way a theory is a set of propositions to guide communication between people, whose purpose it is to bring about these transformations and which is validated by (1) its acceptance by the actors addressed in a non-coercive situation and (2) its efficacy in bringing about the desired transformations" (Habermas 1974, as discussed in Parson and Clark 1995 – cited by Stagl,(2004)).

From an operational point of view, the major strength of this concept is the ability to resolve questions characterised by various conflicting evaluations, thus allowing an integrated assessment of the problem at hand. A representative multi-criteria setback (with a discrete number of alternatives) may be described in the following way: *A* is a finite set of *n* feasible actions (or alternatives); *m* is the number of different points of view or evaluation criteria $g_i$ $i=1, 2, \dots, m$ considered relevant in a decision problem, where the action *a* is evaluated to be better than action *b* (both belonging to the set *A*) according to the *i-th* point of view if *gi(a)>gi(b).* In this way a decision problem may be represented in a tabular or matrix form. Given the sets *A* (of alternatives) and *G* (of evaluation criteria) and assuming the existence of *n* alternatives and *m* criteria, it is possible to build an *n x m* matrix *P* called evaluation or impact matrix whose element *pij* (*i=1, 2 , ... , m; j=1, 2 , ... , n*) represents the evaluation of the *j-th* alternative by means of the *i-th* criterion. The impact matrix may include quantitative, qualitative or both types of information (G. Munda, 1995).

In the case of *AquaDT* the algorithms used have been chosen to approximate the tool to the goal of the AM concept by allowing the, e.g. the incorporation of design, management, and monitoring to systematic investigation of individual statements in order to adapt and learn from/out-of them.

Opposite to the neoclassical foundations of economics, *AquaDT* do not presuppose maximisation as the goal. Using the neoclassical paradigm for investigating a natural resources management decision supposes that the situation is isolable, with clear restrictions, and stable. Interpreting a management decision through this paradigm, we can model the decision problem by an objective function (f) to be optimised over a set of feasible solutions (X). The premise prevailing is the `*homo-economicus*', which means that the decision maker always prefers the solution that maximises her/his welfare. This means that can be handled by the mathematical models. This perspective also supposes that the decision maker is able to articulate her/his preferences according to the strict preference (P) and the indifference (I) relations. Therefore, the maximisation of the decision maker satisfaction is correlated to the optimization of an objective function over a set of feasible solutions (comp. Guitoni & Martel (1998)*.* Under these conditions, traditional water resources tools designed to aid decision makers to e.g. optimise a certain number of objective functions are more often than not overlooked or shelved as they are incapable of taking into account a multitude of social and environmental factors that can commonly carry more weight in a political debate than "the best technical solution" (from just one or a limited number of points of view).

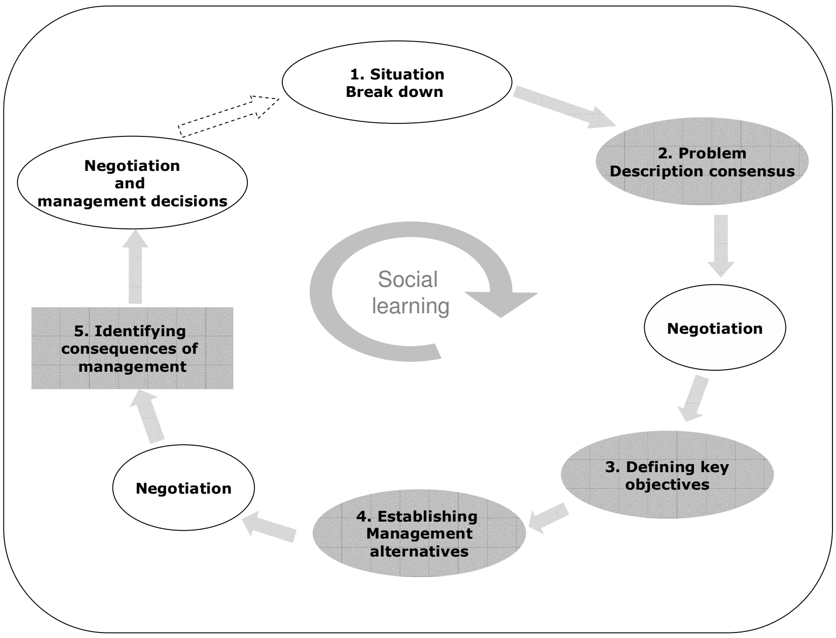
Decisions in water resources management are uncertain and cognitive conflicts arise within groups because the members of a decision group perceive a problem from different perspectives, even when they have similar interests in achieving a goal. Such problems with "typically uncertain facts, disputed values, high stakes and urgent decisions required" are classified by Funtowicz and Ravetz (1990) as belonging to the "post-normal science" paradigm. This means that they are unlikely to be solved with traditional technical scientific methods as stakeholders' perceptions and values become too important not to be taken into account. Usually, decisions in the water sector have been taken in another way not belonging to the description of Funtowitz and Ravetz. Frequently water has been understood as a discrete element capable of being managed in isolation. Yet, in real life it is almost impossible to isolate water and decision making processes regarding water resources, even less in complex situations with different decision makers and different realities. Such decisions are subjective to the context in which different decision makers have a stake. Additionally, decision makers make decisions influenced by their own different considerations (e.g. political, financial, sociological, cultural, psychological, etc). A substantial literature confirms the hypothesis that decision makers' values concerning policy decisions are socially constructed through deliberating (comp. Vatn (2004).

For those decision situations Stagl and Gowdy (2006) proposed a theoretical basis embedded in contemporary welfare economics and experimental economics. They reject the figure of `*homo-economicus*' and re-structured the assumptions of classical welfare economics, where maximisation of single utility is a prerequisite, and suggested that the effects of economic policies cannot be judged without making interpersonal comparison of utility. Howarth (2005), in line with the abovementioned approach, suggested a “deliberate valuation process” (DV). In the DV the stakeholders involved explore the values that could lead to collective decisions during a reasoned discussion loop-process. The main idea of DV is to reach consensus and to develop a mutual understanding of the situation. Additionally it supports the comparison of different policy scenarios and the judgment of them. The DV is of course affected by the opinions and behaviours of the participants as suggested by Stagl and Gowdy (2006). We have used the new economic approach of of DV as basis for the conceptual and algorithmic foundation of *AquaDT.*

**Fehler! Verweisquelle konnte nicht gefunden werden.** elucidates the skeleton of *AquaDT* and the inclusion of the different phases needed when developing tools for adaptive management. Gregory (2000) established the steps of participation in decision processes: (a) framing decisions, (b) defining key objectives, (c) establishing alternatives, (d) identifying consequences, and (e) clarifying tradeoffs. Those are the steps that we have used for *AquaDT*. Further we included a first step: situation break down. This first phase aroused as very important in the process for capturing the different perceptions on the situation deciding commonly for one problem. The phases of *AquaDT* are intended to serve three functions: (1) problem clarification and enhanced communication among scientists, managers and other stakeholders; (2) policy screening to eliminate options that are most likely incapable of doing much good because of inadequate scale or type of impact; and (3) identification of key knowledge gaps that make the *AquaDT* predictions suspect (Walters, 1997).

The phases are captured in the software developed explicitly as *AquaDT* (see Figure 1). Phases in grey are confined within *AquaDT* while the white phases are deliberation phases enhancing the process. When needed, the tool allows for a second loop indicated by the dashed arrow. The elliptic phases represent interaction within the group; the box represents individual tasks. (see section 3.1 for further information)

**Figure 1: *AquaDT* deliberation phases**




Unlike traditional tools carried out by one person or institution, *AquaDT* allows a number of different points of view to be explicitly represented and collectively reflected upon by a group of stakeholders (Ferrand, 1998). The process of *AquaDT* refers to the process of co-constructing a shared representation of reality. The aim is to allow mutual understanding of a variety of different points of views with the eventual objective of aiding decisions on and potentially building consensus over potential solutions or management options for the collective problem (Vennix, 1996). *AquaDT* can also be extended as a way of identifying and designing the social context where decisions are made and considered (comp. Corral & Funcowitz, 1998).

When looking to the aspects of decision making from the point of view of environmental science, we step into the concepts of resilience and vulnerability. Both concepts base on environmental science and biology. They described the ability of an ecosystem to recover after an external harm (Holling, 1978). Decision regarding natural resource management and even extremely in the case of water resources, are decisions taken often after harm or stress conditions. Stress, in the social sense, encompasses disruption to groups' or individuals' livelihoods and forced adaptation to the changing physical environment (Adger, 2000).

Social resilience is a significant component of the conditions under which individuals and social groups adapt to environmental change. It is attached to the concept of adaptive capacity that reflects the learning aspect of system behaviour in response to disturbance (Gunderson et al., 1995). Social vulnerability is the exposure of groups of people or individuals to stress as a result of the impacts of environmental change. Decisions regarding environmental concerns can affect massively the resilience of socio-ecological systems and increase the vulnerability of them. Nevertheless, sometimes the focus on social resilience is not desirable. Instead social sustainability should be encouraged instead, since, e.g. dictatorships are defined as very resilient to changes (Carpenter, Walker, Anderies, & Abel, 2001). Carperter et al (2001) argue that sustainability is an overarching goal that includes assumptions or preferences about which social-ecological system states are desirable.

The aim of *AquaDT* in this regard is to improve social sustainability by including the preferences of the participants in the decision process regarding the desirable state of the social-ecological system. As well *AquaDT* stresses and supports the adaptive capacity of the involved stakeholders through the recurring loop of its nature and the attached learning processes that involves the use of *AquaDT*. *AquaDT* supports the cyclic patterns that are usual in the interaction between humans and nature (Gunderson et al., 1995).

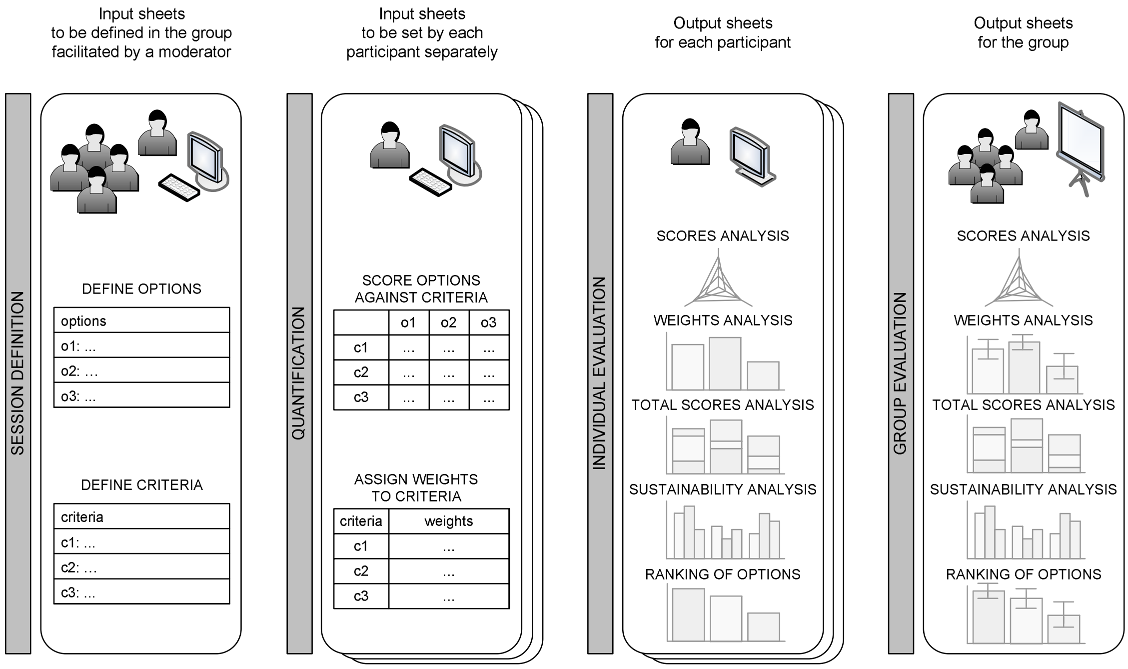
# 3 AquaDT

*The AquaDT* multi-criteria decision aid tool provides a framework for decisions taking in a complex, conflicting and multiparty context in integrated water management. The multi-criteria decision aid tool is set up as a web application[i] (online available). In the following, the basic features of AquaDT are presented highlighting the particularities in the design to support the easiness to use according to psychological findings. Additionally, its potential for being applied in multi-party, deliberative processes are discussed.

## *3.1 Features of the tool*

The multi-criteria analysis in *AquaDT* is organised in four blocks, two of them comprising sheets for the input data of the analysis and two of them providing information for evaluating the results. The evaluation process is an interaction between the moderator and the participants of a session. The tool allows the moderator to give and view the information that is relevant for the whole group. The participants give their individual judgements which are reflected back to them in order to support reasoning. These individual judgements are aggregated and fed back to the group. Several interconnected computers can be used in parallel to allow all participants to give their evaluations and to follow the session on their own screen (see Figure 2).

**Figure 2: AquaDT implementation steps (source: own design)**




## 3.1.1 Input sheets

The basic steps comprise

- the definition of alternative options,
- the definition of evaluation criteria,
- the assignment of scores against the criteria for each alternative, and
- the assignment of weights to the different criteria.

These steps are split up in two blocks. Options and criteria are defined collectively within the group of decision makers facilitated by a moderator; scores and weights instead form the actual core of the multi-stakeholder evaluation and are defined by each participant separately.

The input sheets for the options, criteria, scores and weights are designed to keep the evaluation process simple and transparent. Beroggi recommends tailoring the interface explicitly to the needs of the decision makers. He stresses the need for ensuring that the participants are aware of the meaning of the options and criteria when performing the evaluation (Beroggi, 2000, 76ff; comp. C.M. Brugha, 2004, 1160ff). This is particularly important if the evaluation process is divided into several meetings. Thus, in *AquaDT* e.g. expressions can be chosen that comply with the terminology of the participants and reveal the full meaning of the options and criteria more then pure numbers or abbreviations. These expressions are visible on the input sheets and output graphs as they are originally formulated. Detailed descriptions are to be given to the options and criteria that can be recalled as subsidiary information. The settings of the scale and values given in the criteria input sheet are shape the menu items that are proposed for scoring the options.

Beroggi (2000, 76) argues against presenting the elements to be evaluated in a predefined order but suggests providing an overview map indicating what have already been evaluated. The decision maker should be allowed to decide whether to go through the lines step by step (task strategy) or to give values in a free sequence (context strategy) (ibid., 79 ff, 88). Accordingly, *AquaDT* provides matrixes for the scoring and the weighting task in which the decision maker can choose the cells he or she wants to fill in next e.g. starting with those he or she is most certain about.

As stated by Proctor & Drechsler, decision support tools should permit the continuous update of the decisive parameters (Belton & Stewart, 2003, 281; C.M. Brugha, 2004, 1165; Giuseppe Munda, 2004, 667-; , 2006, 176). Following this suggestion, in *AquaDT* options and criteria can be entered and easily be excluded through check boxes at any time in the process. Adding criteria do not require modifying the whole set of weights as the weights do not need to end up with a sum of 100. Finally, it is intended to support storing different value set for the parameters as scenarios. This will help evaluating the learning and decision process within the group of participants.

### 3.1.2 Output graphs

Results of the evaluation are provided on two levels. The "Individual Evaluation" block displays the results of the individual assessment to the respective decision maker including comparisons with the group results. The "Group Evaluation" block outlines the results of the whole group of decision makers and is accessible to the moderator who may present the results to the group. Both evaluation blocks comprise a series of graphs, tables and other graphical presentations for the scores, weights and the different aggregation steps. To highlight the dispersion of judgements within the group different statistical measures are given.

In the "Individual Evaluation" block for the individual participants, the *Scores Analysis* includes a chart and a table showing the options' given and normalised scores against the set of criteria. An overview of the options' scores across all criteria is given in a spider chart. The *Comparison of Scores* chart reveals additionally to the individual score box plots with the minimum, average, maximum and the range of the middle 50% of the whole group of decision makers' scores. The *Weights Analysis* likewise displays information on the individually given weights and their aggregation to normalised weights. The *Total Scores Analysis, finally,* summarises the individual scores and weights into normalised weighted scores for each option aggregated over the set of criteria. Here, again, a comparison with the group's results is given.

The "Group Evaluation" block is structured parallel to the "Individual Evaluation" and shows the judgements of the group following the aggregation steps used in the "Individual Evaluation" block. Besides the group's mean values, the standard deviations are given to illustrate the group's consensus and dissent concerning the scores, weights and total scores. Additional bar graphs present the scores, weights and total scores of the individual participants.

*AquaDT* aims at facilitating sustainable solutions in integrated water management. To this end, it exhibits a *Sustainability Analysis* providing the opportunity to assess whether the options are fairly balanced between the economic, environmental and social dimensions of sustainability and whether they have particular virtues against these dimensions. First, a list indicates which criteria are assigned to the particular dimensions. The options are located within the well-known sustainability triangle. A location right in the middle of the triangle indicates a fair balance. As a basis, the group has to determine in the criteria definition sheet whether the different criterions refer to one or more of the three pillars of sustainability.

Finally, both, the individual "Individual Evaluation" and the "Group Evaluation" compile a ranking of the options based on the total scores. The 95% confidence interval highlights the robustness of and consensus on this final aggregation.

## 3.2 Supporting deliberation processes

*AquaDT* is explicitly developed to incorporate the views of different stakeholders and to support a deliberation process in order to come to a concluding decision on solutions that are accepted by all participants of the process.

Complex problems typically come along with value conflicts and discordance between the involved stakeholders. Belton & Stewart (2003, 267) identify three approaches how to synthesise the different perspectives in multi-criteria tools: The sharing mode implies common agreement within a group of decision makers on the decisive parameters of the analysis. Most MCA tools comply with this sharing mode as they require a "unitary perspective" (Losa & Belton, 2006, 512). However, this approach is susceptible to persuasiveness, power relations and group dynamics (comp. e.g. Kallis et al., 2006, 230; Losa & Belton, 2006, 512; Stirling, 2006, 98-; Tompkins, 2003, 12; Villa, Tunesi, & Agardy, 2002, 523). The aggregation mode instead acknowledges the differences between the perspectives and tries to reduce them analytically through voting or calculating. Finally, the comparing mode keeps the individual judgements as a basis for deliberating a consensus (Belton & Stewart, 2003, 267). *AquaDT* provides a framework for all aspects, aggregating, comparing and sharing. It allows individual judgements to be given separately and provides a series of visualisations of individual and group results that can be used to compare the perspectives, to learn from each other and – if a consensus is not reached – to aggregate the judgements in a way that the final decision should at least be accepted by all participants.

In order to guarantee a basic comparability between the individual evaluations (Stirling, 2006, 102) a common set of options and criteria is established. This might be done through uncommented collection, deliberation or systematic analysis (e.g. with value trees, comp. Giuseppe Munda, 2004, 675). Yet this collective definition of relevant options and criteria enhances mutual learning in the group of decision makers. "Seeing a criterion that other DMs [decision makers] have proposed is itself an evincing process" as Brugha points out (2004, 1164; comp. Proctor & Drechsler, 2006, 188).

Scores and weights as the core of the evaluation process are assigned by each participant separately. For this cognitively complex procedure the use of several computers reduces time pressure and thus allows the participants to give fully considered judgements. According to Belton & Stewart (2003, 281) multi criteria tools should reflect back to the decision makers the given judgements and the resulting effects on the evaluation. Thus, *AquaDT* does not only display a total scores ranking as a final result, but visualises and synthesises the information and judgements through a range of output information. In the "Individual Evaluation" block, the comparison of scores, weights and total scores graphs confronts each decision makers with the perspectives of other decision makers and might reconsider or affirm his or her own position. These visualisations facilitate conscious reasoning and argumentation of the participants (C.M. Brugha, 2004, 1165).

In the "Group Evaluation" block information is given concerning the distribution of the scores, weights and total scores as well as the sustainability scores and the ranks within the group. The standard deviation, 95% confidence intervals and the values given by each individual participant indicate the degree of consensus and disagreement among the participants (Kallis et al., 2006, 227-; Rauschmayer, 2001, 68-) and avoid drawing overhasty conclusions based on pure averages. These details enhance transparency and help to focus the further deliberation on issues with strong impacts on the results and greatest disagreement. It is possible to retrace whether disagreement is due to divergence in the assessment of the weights or the scores and call for additional expert information or group deliberation. Finally, fields of consensus and "often unsuspected common endeavors" (Villa et al., 2002, 519) can be identified as well as the point at which an option appears to be the preferred one although exact consensus is not reached (Proctor & Drechsler, 2006, 176, 188).

As multi-criteria decision making, particularly within groups of stakeholders, is "more like a 'creation' than a discovery" (Giuseppe Munda, 2004, 673) *AquaDT* can best be used in an iterated manner. In the first step, criteria and options can be collected to get a full range of potential choices and perspectives referred to as the "opening up mode" by Stirling (2006, 101-). It is followed by a "closing down mode" aiming at reducing the complexity of the decision and approaching the core of the problem by decreasing the number of options and criteria (Cathal M. Brugha, 2004, 1165; Tompkins, 2003, 6). This process is supported by the information given in the output graphs. If, e.g. a criterion is weighted very low by all participants, it might be excluded. The discussion process often reveal redundant and biased criteria leading to a refinement and amendment of options and the exact definition of the criteria to be evaluated (Kallis et al., 2006, 229f; Proctor & Drechsler, 2006, 183). The exclusion and potential re-inclusion is easy and the outputs are updated immediately if changes in the input parameters are made due to insights gained during the evaluation process.

The sustainability of solutions is a major objective in many societal fields. There is little help of multi-criteria tools for this issue although some authors like Proctor & Drechsler (2006, 175) or Klauer et al. (2006, 240) explicitly recommend using criteria that reflect the three dimensions of sustainability in multi-criteria sessions. Thus, *AquaDT* integrates a *Sustainability Analysis* of the options under investigation. Listing the criteria relevant for each aspect reveals whether sufficient criteria are assigned to each dimension for a proper sustainability evaluation. Building criteria groupings of 'ecological', 'economical' and 'social' as Proctor & Drechsler (2006, 175) propose does not reflect that certain criteria might contribute to more than one dimension of sustainability. In *AquaDT* it can be chosen whether a criterion shall be assigned to one or more dimensions.

During the deliberation process, the role of the moderator is decisive. His challenge is to structure the process and to decide which of the information *AquaDT* offers is beneficial and suitable to the group's decision making. Presenting the numbers of weights and scores might help in getting a good overview, but might even lead to discussions about the exact values or produce too much confidence in the technically derived numbers and rank orders (Beroggi, 2000, 87; Janssen, 2001, 107). Deliberating disagreement in the individual assessment of weights and scores is ambivalent as well. If the individual values are presented other participants might get new insights about the different perspectives (Klauer et al., 2006, 249) and the origins of divergence can be directly retraced (Kallis et al., 2006, 228). Proctor & Drechsler (2006, 187) experienced in a deliberative multi-criteria session that the process of each person defending his or her criteria weights revealed important information and raised some participants' awareness concerning the relevance of some criteria. However, similar to the problems in the sharing mode (see above), discussing about particular judgements and asking the respective decision makers to defend their position might produce discomfort and might extort them to change their judgements due to group pressure, power and personality. Suggesting an anonymous iteration of scoring and weighting for all participants after providing sufficient time for argumentation is an alternative approach to deal with disagreement. Thus, *AquaDT* offers a set of output graphs, but gives the moderator the possibility to show or hide them according to the group's characteristics and the situation at hand.

Additionally, the moderator is in charge of avoiding pitfalls in the evaluation process and ensuring that the decision makers have the proper and equal understanding of the criteria and weights. Belton & Stewart for instance notice that people often have intuitive concepts of the importance of criteria that do not match the algorithmic meaning of the weights in the model (2003, 265). Marttunen & Suomalainen point to biases in the weighting process that might be prevented by sufficient education of the decision makers (2005, 37). The moderator's advice is important in the context of indifference or preference thresholds as well. It is technically difficult to incorporate those thresholds recommended e.g. by Munda (2004, 675), Refsgaard (2006, 179) or Marttunen & Suomalainen (2005, 43) but a moderator might suggest changing cardinal criteria into binary or ordinal criteria in order to express the meaning of these concepts. Furthermore, moderation is crucial for inducing the 'closing down mode' (Stirling, 2006, 101f) when the decision makers realise that criteria and options shall be excluded from the further evaluation process they have proposed. Finally, a moderator can facilitate defining integrative options. As Kallis et al. point out, "stakeholders may propose individual solutions, failing to see the 'larger picture'" and failing "to capture the integrative potential and economies of scale presented by combined solutions" (2006, 230) that is particularly important for sustainable solutions. The moderator shall not assume the definition task by himself but initiate the deliberation on combining options and measures.

# 4 Testing *AquaDT*

After testing *AquaDT* and coming back to the citation of Habermas (1974) about that a theory is

1. a set of propositions to guide communication between people,
2. whose purpose it is to bring about transformations and
3. which is validated by
    - (1) its acceptance by the actors addressed in a non-coercive situation and
    - (2) its efficacy in bringing about the desired transformations

We can say that the phases of *AquaDT* correspond with his description resulting in a tool that try to formalise, guided and structure communication between people regarding decision in environmental management questions.

*AquaDT* has been tested and used so far experimental within the *AquaStress* project during the different phases of the tool in different case studies. First, we tested the tool in Portugal during the origination of the tool. Second, we tested in Bulgaria while introducing stakeholders' preferences. The participants in the first two sessions were participants belonging to the local stakeholder groups of Portugal and Bulgaria attached to the *AquaStress* project. The tool was applied to the examination of water resources issues and problems in both countries.

Third, we used *AquaDT* as a functioning tool with students of System Sciences of University of Osnabrück (Germany) in two consecutives years. During the three phases modifications were introduced to make the tool user-friendly and more accurate to the needs of the users. Further examples can be found in Panebianco and Mánez (forthcoming).

Deliberative and participatory techniques like *AquaDT* can be very helpful in formulating a policy question, considering what should be done in a particular policy area. The integral component of AquaDT has turned to be evaluation. The role evaluation can play in any participatory process can be extremely important for three main reasons:

- as a aid for the organisers and participants to ensure that the programme and sessions are achieving their objectives and any problems encountered can be treated on an ongoing basis through adaptive management;

- as an intervention measure if the evaluation is carried out by the participants, as they will be required to think about what is occurring in the process which can then potentially change their behaviour and have further impacts on the process and its outcomes; and

- as an aid to the overall utility, outcomes and perceptions of the process that can be used to determine how such a process can be improved in the future or not reused again. (Farrel & Ferrand, 2005:39)

*AquaDT* had further positive feedback in terms of

- learning value and creativity that occurred in the problem situation and problem formulation phases.
- the inclusion of all participants believes during the creation of criteria
- the formation of a basis for discussion "without" struggles
- the potential for moderating "crisis"-situations, and
- the potential for increasing sustainable relationships amongst participant stakeholders and therefore the sustainability of management decisions among a big group of stakeholders

Preliminary results showed that the methodology suffered from:

- time issues (mostly belonging to the extension of discussions between participants regarding water resources issues),
- complexity issues regarding different knowledge basis of the participants (about the amount of interconnected relationships)
- how to include expert information without biasing the participants knowledge, and
- credibility of results

Altogether we can conclude that the methodology and the developed software for supporting deliberation processes has succeed the goal that we had of creating a helpful tool for adaptive, participatory, and multi-level management arrangements. Furthermore, *AquaDT* also have an explicit status as it is more generic than others because *AquaDT* does not depend so much on the local situation, except in political and social terms. It can be considered to be just as controversial to switch an existing agricultural system as to switch the problem assessment and the modelling processes that are already institutionalised. *AquaDT* also has the benefit that it can be applied, adapted and integrated into all kinds of environmental management situations.

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