The AquaStress Integrated Solutions Support System

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EXTENDED ABSTRACT

AquaStress (2005-2009) is a research project funded by the European Commission (EC). The project aims to deliver enhanced interdisciplinary methodologies enabling actors at different levels to mitigate water stress problems. Both quantitative and qualitative aspects are covered. The project is test-site and stakeholder driven, indicating that any developments are directly related to a variety of study areas and stakeholders who actively participate in the project.

Within the AquaStress project, much effort is put in designing an "Infrastructure to support solutions system" (ISSS). The overall objective of this task is to develop a flexible toolbox that supports the various steps in a collaborative planning process. Some of these steps require tools for stakeholder interaction; others involve both simple and complex modelling or support a selection of improved sets of options for water stress mitigation. The ISSS will have to deal with a large variation in the knowledge and information about the different aspects of water stress in the different case studies. Also the information and knowledge that will be delivered within the AquaStress project will be very dense and diverse. The innovative aspect of this toolbox is that the tools can be linked together quick and easy. This makes the collaborative process itself less dependent or hindered by the limitations and inflexibility of many contemporary decision support tools. To facilitate linking of new and existing models, the system will comply with the OpenMI standard (Gijsbers et al., 2002; Gregerson et al. 2004). A core part of the system will be a knowledge base / information system that provides integrated information of the (combined) effectiveness of mitigation options.

The different phases in the planning process, as well as the different views of stakeholders / users require a tailor-made approach. In this project, as well as in other projects with similar goals, we will achieve this through a generic framework for generic tasks (e.g. model linking). On top of this framework, dedicated tools will be linked, tailored to the requirements of the stakeholders. This is a big challenge that can only be successful by organizing existing scientific knowledge, information technology and case knowledge.

1. INTRODUCTION

1.1. The AquaStress project

Quantitative and qualitative aspects of water stress are a global problem with far-reaching economic and social implications. To mitigate water stress problems, the European Commission supports the Integrated Project (IP) AquaStress within the 6th research framework program. The project aims to deliver enhanced interdisciplinary methodologies enabling actors at different levels to mitigate water stress problems. An important objective of AquaStress is to find new insights into the pressures and drivers of water stress in different regions of the EU, and in the regional aggregation of stakeholder based decisions. An IT knowledge management system will be developed to support the planning and decision making process.

A new governance concept has recently emerged. This concept assumes that planning and decision making processes are the product of complex interactions between governmental and non-governmental organizations, each seeking to influence the collectively binding decisions that have consequences for their interest. This concept is based on the assumption of the model of “co-production of knowledge” (Callon, 1999). AquaStress will account for this new governance. Therefore effects of measures need to be evaluated in an integrated context, and information needs to be accessible in the way that all different types of stakeholders achieve a common understanding of the problems, objectives and solutions.

Most importantly, to achieve effective water stress mitigation, stakeholders need to be closely involved to such an extend that the selected mitigation options are understood, accepted and broadly supported. Therefore, the project adopted a test-site and stakeholder driven approach. This means that any developments are directly related to a variety of study areas and stakeholders actively participate in the project.

The AquaStress-IP is organized in three phases; (i) characterization of selected reference sites and relative water stress problems, (ii) collaborative identification of preferred solution options, (iii) testing of solutions according to stakeholder interests and expectations (Figure 1).

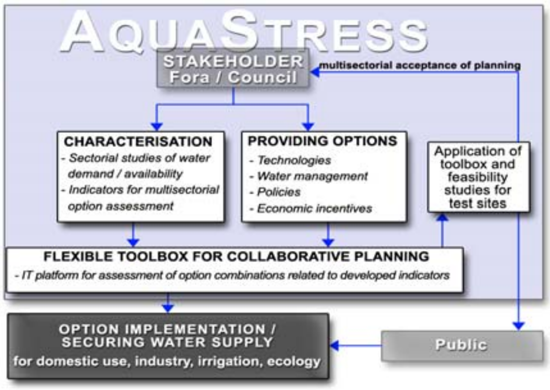

Figure 1: Schematic overview of AquaStress.

1.2. Objectives of the IT work block

AquaStress Work Block 4 deals with the development of software: the Integrated Solution Support System (ISSS). This ISSS is a flexible toolbox that supports the various steps in a collaborative planning process. Some of these steps require tools for stakeholder interaction (e.g. gaming tools), others involve both simple and complex modelling or support a selection of improved sets of options for mitigation. Within the framework of the case-driven approach, the development of a knowledge / case base that allows mapping information from case to case (case based reasoning), is something which requires specific attention. This should be accomplished in such a way that use of practical experience and scientific knowledge is maximized and structured for reuse. Given the complexity of such a toolbox a third aspect of the overall objective is to provide transparent guidance and reporting structures.

1.3. Scope of the paper

Though flexible systems appear to be the way forward, they pose a specific problem of themselves: Guidance is required on what parts (e.g. information, tools, knowledge) need to be used in specific cases. Additionally instructions are necessary on how to select and link together the right components at the right time for a specific case.

This paper wants to clarify the rationale of the ISSS idea by providing some insight in what the ISSS is. We give special attention to the position of stakeholders and users in relation to the user requirements of tools and the different phases in participatory planning processes.

2. PARTICIPATORY PLANNING AND SUPPORTING TOOLS

2.1. Trends and phases in planning

For the purpose of tool classification a simple schematization of the collaborative planning process is presented in figure 2. In general, such a process consists of a closely interlinked 'planning process' path and 'information delivering'. We distinguish 'start / stakeholder analysis', 'problem definition', 'solution selection' and 'implementation'. From a tool perspective these phases differ in the type of systems required. At all stages of the planning process stakeholders have to be involved. Furthermore, all steps require information that is tailored to the needs of the collaborative process, thus towards different types of stakeholders with different levels of knowledge. In complex situations such as integrated river basin planning, this means that very specific expert knowledge is integrated and made available as understandable information for non-specialists, amongst whom the general public.

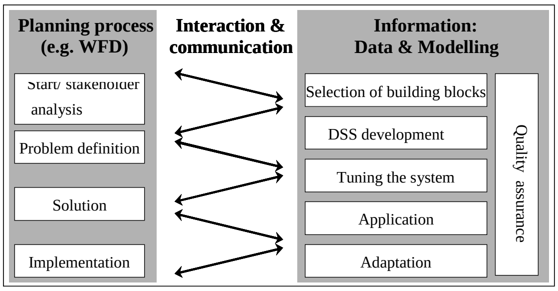

Figure 2: Simplified representation of the participatory planning process

In the following paragraphs we give examples of tools and methods for the different phases in participatory planning, focusing on the participatory aspects. Another European integrated project called SEAMLESS made an excellent overview of participatory methods, guidelines and good practice guidance. (Bousset et al, 2005). Although targeted towards the agricultural domain, SEAMLESS aims at comparable integrated solutions and stakeholder involvement. Mutual knowledge sharing and potential cooperation should be considered.

2.2. Phase 1: Stakeholder analysis

At this stage it is more important to identify the stakeholders and relevant experts and assess their awareness of the problem than to achieve detailed information on the nature, size and urgency of the problem. Stakeholder analysis is "an approach and procedure for gaining and understanding of a system by means of identifying the key actors or stakeholders in the system, and assessing their respective interests in that system" (Grimble and Chan, 1995) . The objective is to change situations of potential conflict into situations of potential cooperation. Conditions where stakeholder analysis is crucial are common in natural resource management (Grimble and Chan, 1995).

There are various methods for stakeholder analysis, but in general there are two types: institutions approach (focus on the identification of stakeholders and characterize these on some institutional features) and cognitive approach (aim to understand and disclose the deeper perceptions and argumentations of the various stakeholders). (Enserink and Mayer, 2001)

In this early stage of the process, it is very important that data and discussions are open and traceable. A good way to accomplish this is the use of Group Support Systems (GSS). GSS are information systems "that aim to make group meetings more productive by offering electronic support for a variety of meeting activities." (de Vreede, 1997). The Group Decision Room is an example of a GSS software tool to support brainstorming, usually generating ideas quicker than in traditional settings. It allows large numbers of people to participate in strategic brainstorm sessions simultaneously. The tool can be tailor made for specific needs.

The outcome of this first stage should be increased understanding of water stress, and some sense of size and urgency of the problems. There should also be agreement on the scope of the next steps. From discussions it should become clear what aspects of the system at hand should be looked at closer for the next stage.

2.3. Phase 2: Problem definition

The objectives of this stage are to increase both the understanding of the system at hand and the understanding of the impact of stakeholder's behaviour.

Cognitive mapping is a method of defining relationships between concepts involved in a decision-making problem. By means of cognitive mapping, implicit knowledge (available only in the participants minds) can be stored, analyzed, and presented. A map of a problem is created in which causes, effects, measures, functions, goals and so on are schematized (Ubbels and Verhallen, 2000). A great variety of software tools has been developed for eliciting and structuring knowledge of individuals or groups

Relatively new in this field are gaming tools. These tools are extremely useful when aiming at common understanding between different stakeholders. Gaming tools can be used to get common understanding of problems in river basins, but also to achieve understanding of (conflicting) interests, effects of behaviour patterns and decision making processes.

2.4. Phase 3: Solution finding

At this stage the stakeholders, experts and IT developers need to deepen the knowledge to a point where effects of mitigation options can be assessed. The uncertainties surrounding the system and option mitigation effectiveness should be transparently determined and recorded. Costs and socio-economic consequences also require attention.

A proven method for discussion about the problem, the effects and the alternatives is scenario construction (Enserink, 2003). The process of creating scenarios can be an important tool for cooperation and building trust. Brainstorming, elaboration and prioritization of driving forces and creation of a scenariologic lend themselves very well for a workshop-like setting. It's a creative process leading people away from conflict towards a collaborative mind-set, discussing plausible alternative future scenarios.

Scenario based simulation is also the essence of many modern computer games. In these systems an intense sense of perceptual reality is created, taking a player into another world. These virtual worlds offer people a safe environment for experimenting with strategies. Stakeholders can participate by testing strategies and building a better understanding of the aspects of the real world which the virtual world depicts (Wien and van der Wal, 2004). In literature is described how these virtual worlds offer a deep approach to learning; not just seeing the world differently, but seeing one's own position in the world differently (Martin, 1999). This is one of the key factors of successful participatory planning.

In scenario studies as well as in simulation gaming simple and complex models play an important role. To maintain trust in the expert tools, these models cannot be black boxes. Transparency has to be provided in the choice and quality of use of the models. Also collaborative model development, a relatively new approach to model development, can increase trust in models. Again, building from experience, scientific proof and empirical evidence gathered in similar cases can be of great value.

Another major advancement in recent years is the use of GIS in participatory settings, sometimes called community mapping or Public Participation GIS (Craig, et al. 2002). It has been noted that stakeholder participation in spatial planning benefits significantly from a common geographic notion and basis. A good example of sharing geographic information and use in a participatory setting is the tool MAPTALK™, a participatory design tool for spatial planning (Wien et al., 2003).

2.5. Phase 4: implementation

The implementation phase for spatial planning processes involves the dissemination of (spatial) information regarding the outcomes of the planning. The relevance of good communication and information dissemination in this phase is often neglected, but it is of great value for the broader acceptance of plans.

In the European Union, this kind of information on spatial plans, areas with (environmental) restrictions, risks and hazards is subject to a new regulation where governments are obliged to provide citizens with the relevant information. This has resulted in several standards on sharing data with EU wide initiatives like INSPIRE (http://www.ec-gis.org/inspire/home.html). The broader use and acceptance of these kind of protocols and (data) standards is of great importance to successful data dissemination and its usage.

3. THE ISSS CHALLENGE

In the previous section, several computer tools were introduced that may facilitate the collaborative search for water stress mitigation options. The ISSS system should allow such tools to interact with knowledge bases and a number of other perceivable tools, such as case-based reasoning tools, uncertainty assessment tools and multi-criteria-tools.

Integration of different domains in water modelling has lead to a broad availability of advanced modelling suites. An example is the widely supported framework for water management simulation software, the Generic Framework (Blind et al, 2001). Specialists use such models and modelling suites and (try to) translate the results to end-user needs.

In the last decade systems have been developed that integrate more and more domains, and can be used by non-specialist users. These developments often supported planning processes as described in the previous section.

These systems are of high quality, but adapting them to new situations, e.g. changing and adding models or changing the geographic area they apply to, is far from easy. It often requires much effort by both model and tool specialists and software developers. It is a major challenge for tool developers (software developers and modelling specialists) to match the demands and the speed of the planning process.

Another challenge is to create a truly stakeholder driven process of developing an planning support system. Since it are the experts who in general initiate the solution searching process, there is a natural tendency to provide tools that give too much direction in problem definition, solution space, and technical means to be used. This does not mean that the experts are wrong! Only, the increasing need to involve broader groups of stakeholders, and their increasing interest to be involved in local policy requires an unbiased start. Being right is not proving right.

Since the authors are convinced that it is not possible to build a single system which can always support the collaborative process in all situations, the AquaStress ISSS challenge is to develop and implement an open toolbox which supports (more or less in real time) the unbiased collaborative process. The AquaStress ISSS should be more seen as a flexible toolbox serving different users with different goals.

4. FUNCTIONALITY AND INTERACTION DESIGN

There will be a large variation in the knowledge and information about the different aspects of water stress in the different case studies. Also the information and knowledge that will be delivered within the AquaStress project will be very dense and diverse. Therefore the ISSS will be based on different levels and sources of information. One of the requirements is to easily facilitate linking of new and existing models. Therefore the system will comply with the OpenMI standard (Gijsbers et al., 2002; Gregerson et al. 2004). OpenMI stands for Open Modelling Interface, a standard for linking (simulation) components and tools. The use of these kinds of frameworks for knowledge system development increases the efficiency of investment and minimizes possible risks (Wal, et al., 2003). The OpenMI has facilitated linking many disparate watercycle programs. By providing a framework to better integrate the modelling work, OpenMI has concomitantly provided a social framework to encourage the individual teams to work together to provide better modelling data for the decision makers. (Dudley et al., 2005).

A proven framework for interactive tool design (Wien and van der Wal, 2004) is presented in Figure 3. The figure shows the three pillars representation, interaction and degrees of freedom in their mutual cohesion. The first aspect in interaction design is the representation of the relevant aspects of the application domain of the tool. This can vary from virtual world representations like in certain games to more schematic representation of a mathematical model. A second aspect of interaction design is the freedom allowed to the user and the way she/he uses the tools. In tool design a special place is reserved for so-called ‘narratives’, which are linear story-lines (animations, movies) without much to choose for the user. The third aspect of the design framework involves the level of interaction. Depending on the aim of the tool (from learning skills to developing/testing strategies to creating self awareness/sense) the design has to be tailor made and meet the specific requirements on representation, degrees of freedom and level of interaction.

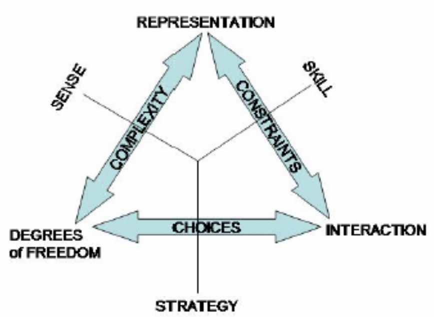

Figure 3: Design framework for interactive tools

In congruency with this interaction design framework applications for different user roles can be distinguished. The sister project SEAMLESS has made a classification of user roles (van der Wal et al, 2005). These different user roles refer to the broadband of (possible) users of integrated systems and their requirements and expectations of the system. When accommodating both the domain expert and the end-user, the user-interface should be dedicated to the role. We present here different user-interfaces that respond to the expectations of different users and the way the interact with the system.

The first view on user-interfaces responds to the requirements and expectations of domain experts.

Typical characteristics of such an application are: flexible, very detailed systems with extensive functionality (many degrees of freedom and a high level of interaction) that requires much knowledge from the user.

The second view is one of an application for decision makers. Typical characteristics of such an application are that the user is guided through the application and has limited functionality. Using the application requires ‘little’ knowledge.

The third view is one of an application for a wider audience (e.g. general public or policy makers). The term we use for these applications are “Reference book”. Typical characteristics of such an application are: easy to use, guided, with little functionality and little knowledge required. An impression of a graphical user interface of this view is presented in figure 4.

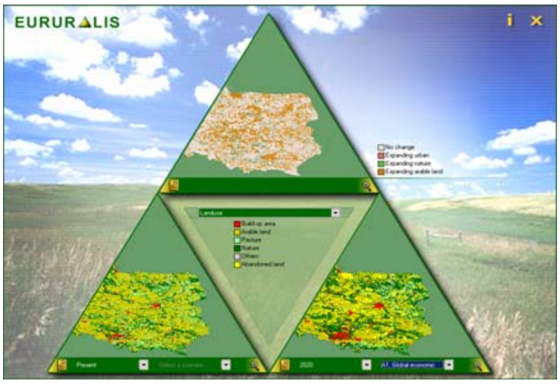

Figure 4. Impression of a graphical user interface of a reference book (Klijn and Vullings, 2005).

The fourth view is one of a simulation gaming application. Typical characteristics of such an application are that it offers a virtual world that stimulates experimenting. It requires little knowledge to use the application. An impression of a graphical user interface of this view is presented in figure 5.

Figure 5: Impression of a graphical user interface of a simulation game on water management (Wachowicz et al., 2002)

OpenMI has proven to be flexible and adequate enough to use in DSS development (Dirksen et al., 2005). With integrated models as a basis and dedicated OpenMI compliant tools for different users, the models can be accessed to accommodate the experts as well as a wider audience.

5. CONCLUSIONS

The concepts put forward in this paper on development of an integrated solutions support system, show that different phases in the planning process, as well as the different views of stakeholders/users require a tailor-made approach. In the AquaStress project, as well as in other projects with similar goals, we will achieve this through a generic framework for generic tasks (e.g. model linking). On top of this framework, dedicated tools will be linked, tailored to the requirements of the stakeholders. This is a big challenge that can only be successful by organizing existing scientific knowledge, information technology and case knowledge.

The OpenMI architecture for linking of (simulation) components and tools will be adopted as the base design and as linking environment. Although developed for the water domain, OpenMI is not domain specific and can be easily used in other domains as well. The Basis of the ISSS is more generic and can be used for other issues such as floods or the implementation of the Water Framework Directive (WFD).

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