Learning experiences from working with tools and training for adaptive management at the interface connecting researchers and practitioners

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1 Introduction to adaptive water resource management and the role of tools and training

Water managers need to solve a range of interrelated water problems, such as balancing water quantity and quality, flooding, drought, maintaining biodiversity and ecological functions and services, in a context where human beliefs, actions and values play a central role. Furthermore, the growing uncertainties of a global climate change, population growth, and how global economic growth influence local demands and supply of water, poverty and vulnerability of different groups, pose a number of challenges for water managers and policy makers in river basins all over the world.

This means that water management and decision making have become much more challenging and require a much more systematic learning process, in order to better understand and manage the uncertainties of responses to taken measures, observations, interpretations, new insights and effects of political measures. Furthermore, links with other sectors, with water users up- and down stream, with institutions, at various scales and time frames, are required in order to deal with the river basins in all their complexities. There is a need for tools assisting water managers and stakeholders to understand and appreciate their positions, for scenario planning,

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generation of hypothesis, experimental approaches, stakeholders realizing own tasks and agreement upon implementation, hypothesis testing and learning etc. Water managers therefore must facilitate that changes, uncertainties and complexity are fully considered for decision making and try to build adaptive capacity in order to deal with unforeseen changes. This leads to more decentralized infrastructure, use of flexible monitoring and social learning, and more emphasis on the importance of stakeholder participation. Furthermore it requires open and innovative decision processes at various levels.

In order to enable a flexible integrated water resource management approach practitioners need appropriate guidance, tools and training. The purpose of the present paper is to explain how we in NeWater in an adaptive way, at the interface between researchers in NeWater and practitioners in case studies and beyond, managed and learned to develop a framework – an adaptive guidance-tool-and-training approach, to describe this developmental process, and how we test the approach in NeWater case studies.

1.1 Adaptive water resource management (AWRM)

AWRM involves learning from management actions and using that learning to improve the next stage of management (Holling, 1978). Adaptive management (AM) treats policies and management interventions as experimental probes designed to learn more about the system; they are not confident prescriptions (Lee, 1993). Monitoring before and during the intervention enables the system response to be determined and thereby allows managers to learn from past experience and to translate the best of current integrated water resource management research into practice. It is anticipated that AM will (Allan & Curtis, 2003):

- Allow management to proceed in the face of complexity and uncertainty
- Make learning about water resource systems more efficient
- Help build flexible management capacity
- Be a large scale, holistic alternative to reductionism science
- Involve social-political values in water resource management

Walters and Holling (1990) describe adaptive management as a structured process of learning by doing with the aim being to:

- Work with stakeholders to develop a shared understanding of the system to be managed and the desirable outcomes, by developing a system model that can be used for policy screening;

- Use this model to identify policies that are likely to succeed or that probe key uncertainties;
- Implement policies;
- Monitor and evaluate outcomes; apply learning to develop a better understanding of the system.

This means that AWRM acknowledges explicitly uncertainties and complexity of the systems to be managed. It is a systematic process to improve management approaches by learning from the consequences of implemented management strategies (Pahl-Wostl and Sendzimir, 2005).

According to NeWater the moving toward AWRM then is to facilitate a change and transition process which (Pahl-Wostl et al., 2006):

- Substitute command and control *with* a regime that negotiates acceptable solutions, and searches for win-win solutions
- Substitute prediction, quantification of risks and choice of optimal strategy *with* acknowledgement of uncertainties in management process, a scenario approach, experiments and learning
- Move from a centralised, hierarchical governance *toward* a polycentric governance with shared responsibilities and participation of stakeholders
- Switch sector management *with* cross-sector policy integration
- Move from fragmented understanding *to* shared information
- Substitute large, central infrastructure *with* decentralised infrastructure, and
- Substitute controllable technical infrastructure *with* multi-functional landscape with increased adaptive capacity

1.2 The role of tools and training in AWRM

The term "tools for AWRM" has an ambiguous meaning. Tools for AWRM could be new tools with a certain documentation of how to apply such tools as part of the planning cycle in a fully adaptive way. It can be tools for AWRM by adding interfaces to tools which provide guidance in uncertainties and complexity according to the Management and Transition Framework (MTF) also developed by NeWater. And it could be the selection of new tools tested for AWRM from the seven case studies enhanced for AWRM and tested by researchers in NeWater. Finally, it could be a possible linking of different tools providing a suite of AWRM tools applicable as guidance-tool-and-training approaches as suggested by NeWater. But tools for AWRM could also be education. As stated by Dewey (1944):

"Only gradually and with a widening of the area of vision through the growth of social sympathies does thinking develop to include that lies beyond our direct interest: a fact of great significance for education". Why learning and thinking is important for AWRM becomes clear in the following definition of "thinking" according to Dewey (1944): *"Thinking, in other words, is the intentional endeavour to discover specific connections between something which we do and the consequences which result, so that the two become continuous"*. Isn't that the way the tools for AWRM should be used, to help us to facilitate system analysis, thinking, bargaining and reflecting. To approach AWRM with tools without training would not be possible, whereas to facilitate training with tools is what is provided by NeWater.

2 Framework approach: developing an interface between practitioners and scientific community

If we view our work block in NeWater responsible for developing an approach for guidance-tool-and-training (WB 4) as an open system, a sub-system in NeWater, then WB4 depends on its environment and the other 5 work blocks of NeWater including the seven case studies. According to this model of the open system (Hatch, 1997) WB4 takes in input and demands for guidance, tools and training coming from NeWater and case studies. These inputs are then transformed to outputs in the form of new guidance, tools and training organised in case studies, and linked to the MTF, a process that at the same time sustains the life of WB4 and NeWater. According to Boulding's hierarchy of systems, the open (living) system has the characteristics of self-maintenance, throughput of material, energetic input and reproduction. Examples of open systems are the cell, the river and the flame.

AWRM for sustainable exploitation of the natural resources and the components of the freshwater cycle in transboundary river basins with water flowing in the rivers, buffered in groundwater and reservoirs, and exposed to the needs of different water users in terms of a supply with good quality and sufficient quantity, require a flexible management approach with proper tools for dealing with uncertainty in data, models and the planning cycle. Furthermore different types of complexity have to be dealt with e.g. dynamic, social and emergent (Scharmer, 2007). Dynamic complexity requires proper tools for system analysis. Social complexity requires proper tools for multi-stakeholder dialogues. Emergent complexity requires tools for deeper reflection about the emerging profound change as

the attempt to imagine what is likely to happen in the river basin in the near future. The resulting actions and planning must assure a stable enough supply of water to different users, and prevent catastrophic situations in drought and flooding periods. In river basins with profound change due to climate, globalisation and unforeseen interactions between different sectors and/or scales, there is a need for new tools capable of analysing, interpreting, monitoring and evaluating complex relationships and problems. Enhancement of tools and guidance has to target needs coming from the river basins and current knowledge about problems with the management regimes. Our visions for how to enhance tools for AWRM, thus has to be identified based on empirical data describing the needs for managing river basins. Later we need to circulate back to the river basins guidance and enhanced tools for AWRM in the form of adequate approaches for demand oriented training, which properly demonstrate and identify the needs for transition and change of the management regime toward a more adaptive regime.

When viewing our WB4 as such an enterprise and a biological organism (Miller and Rice, 1967), WB4 is separated by a boundary from case studies and other work blocks in NeWater. WB4 takes up roles and adapts its primary tasks, in order to meet requirements for deliverables, but also to engage in interrelationships with others, both within WB4, with other subsystems of NeWater, and beyond (based on feedback from GWP, IUCN and other international organisations). General system theory here provide an understanding of the nature of managing and organising by focusing on attention to interdependence, interaction and interconnection between parts; by focusing on the importance of the boundaries between parts, role systems and the management of the boundary. And since WB4s primary task is to develop guidance-tools-and-training for AWRM, the tools for AWRM become "lenses" connecting theory about AWRM and uncertainty with practical water management regimes in case studies.

As illustrated in Figure 1 we are dealing with a complex adaptive process at the interface between theory and practice. First we provided a state-of-the-art report about tools for integrated water resource management based on theory. Then we collected ideas for enhancement and for new AWRM tools with inspiration from needs coming from case studies. Next we suggested training plans with AWRM themes, and collected needs for training from case studies. Finally, the MTF was provided by another work block in NeWater, and we started developing a new tool for uncertainty guidance in decision making and planning cycle. At the same time we carried out train the training work shops in case studies with practical enhanced AWRM tools.

By applying tools, we collected knowledge about the management regime, and needs for guidance and identified examples. Furthermore, we decided to go for a handbook for AWRM with guidance and examples, which should be implemented in the WISE RTD portal. In the following we will try to describe this path of discovery of needs in more detail.
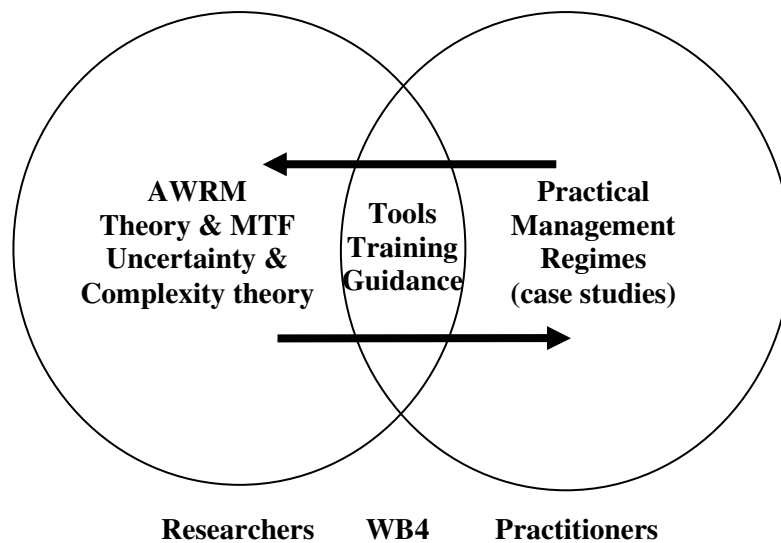

Figure 1 Guidance, tools and training are lenses for connecting theory about AWRM and practice in NeWater case studies. WB4 here is at the interface between researchers in NeWater and Practitioners in case studies

3 The process of developing an approach for guidance-tools-and training for AWRM

3.1 State-of-the-art-report

The starting point for WB4 was to compile a State-of-the-art report with a tool classification and overview. In this we defined a tool for adaptive management as: "A tool supports operational actions to perform IWRM".

We realised that a tool can be a guideline, a procedure or protocol, a method or technique, a device, an apparatus and a software program". The broad range of tools available for integrated water resource management (IWRM) includes e.g. GWP Toolbox, HarmoniCA /Catchmod tools, decision support systems, simple and comprehensive models and participatory tools. Tools for AWRM can support the transition processes in different ways (Barlebo et al., 2006):

- Analysing ambiguities and mental frames that may hinder agreement on a common goal or state
- Developing scenarios or monitoring programmes to analyse changes in the water availability
- Analysing and evaluating different management strategies and experimental approaches
- Supporting the implementation of a transparent integrated research policy process
- Supporting the learning process where learning encompasses a wider range of processes

3.2 Gap analysis (for tools)

Parallel to the state-of-the-art-report WB4, with inputs from case studies, also compiled a desk study of tools used in the seven case studies. This report showed that 75% of the identified tools were models. Models of various types including: flood prediction, drought forecasting, groundwater resources, irrigation models, soil water and water use. The remaining 25% were a mixture of data bases and guidelines of various types. This meant that there was a strong tradition to view tools as models. In NeWater the definition of a tool was broader. The need of new tools which we had identified from research action plans, baseline reports, stakeholder reports etc. belonged to the following main categories:

- Tools to facilitate integration (guidelines/DSS/models)
- Methods to improve stakeholder engagement (guidelines /DSS)
- Tools to improve water use / productivity (guidelines / models)
- Real-time GIS-based Data Bases
- Improved flood / flow / drought forecasting models (models)
- Legal tools to improve harmonisation of regional planning

3.3 Framing and reframing the process

Discussions held at a NeWater General Assembly in 2005 at Mallorca were important for determining the direction which WB4 chose. The discussion at Mallorca gave us a clearer understanding of the need of closer cooperation between WB 4 and people from the case studies. Furthermore, it was realized that the case studies should not only be involved for training in a specific tool, but should rather be taught more about the wider concepts of adaptive management, supporting tools, and MTF. The result of our discussions at Mallorca is shown in Figure 2. This figure showed our idea at that moment for linking WB4 work, tools and training. At that moment we didn't have any idea of how the MTF would look like, so we instead attempted to link tools to themes of the planning cycle.
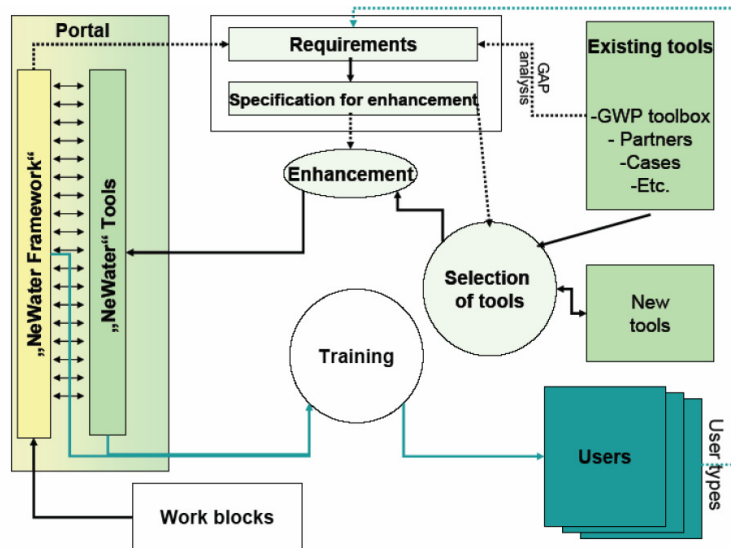

Figure 2: Approach for identifying and enhancing tools with links to the Management and Transition Framework (MTF), training and the needs of users (testing enhanced tools for AWRM in NeWater case studies)

As can be seen from Figure 2 we evaluated, that tools could be selected from existing tools and subsequently enhanced for AWRM by specifying requirements based on MTF and gap analysis. After the enhancement of tools we foresaw an uploading of tools to a portal (toolbox) which integrated and related the tools to the MTF under development in WB 1 and 2.

Next, we assumed that tools and MTF should be prepared for training in the case studies, which would target different users (water managers, stakeholders etc.). This should be a participatory process, since users should be actively involved in defining the requirements for the enhanced tools for AWRM.

At a number of WB4 meetings, between Mallorca and the next General Assembly a year later in Hortobagy, in the process of enhancing tools and developing concepts for training in case studies, we discussed and realized that it was not possible to clearly distinguish between tools for AWRM and other existing tools. It was more a question of how tools were applied, in an adaptive way or not. A tool could not by itself define the management regime, it was rather the opposite way around. In addition we noted, that tools in general were fragmented, not integrated, and had often not been tested by water managers. As the gap analysis had illustrated there was a shortage of tools which could help integrate and provide a holistic analysis of a wide range of interdisciplinary factors (Bromley, 2006). As a result of the feedback from case studies, we realized that training in all selected enhanced tools was not viable because of time, costs, relevance and limits of resources. Instead we needed to select a different approach for AWRM training, based on demand oriented training and what we later termed the "broker concept" (Rotter et.al., 2006; see below).

3.4 The broker concept

The broker concept for training in NeWater can be distinguished in three phases (see Figure 3):

- Planning with involvement of WB4 and case studies

- 'Train the Trainers'(TtT): workshops trainers selected by case studies are trained in AWRM and supporting tools by WB4

- 'Train the Practitioners' (TtP): Water managers are trained in TtP workshops by trainers trained in TtT.

After the train-the-trainer workshop the guidance material would be adjusted based on our learning from the TtT, and translated by local trainers from case studies to the local context, language and metaphors used in the case studies. Transbasin cooperation was also allowed by inviting a participant from other case studies to attend the train-the-trainer workshops in order to allow training in all aspects and themes for adaptive management.

The examples of enhanced tools listed in Figure 3 are useful at different stages of the policy cycle.

It was decided that each training course should refer to one or two specific "themes" within a block of the AWRM planning cycle. Adaptive IWRM themes, and not merely single tools, should be the key interface for linking the guidance materials being developed in NeWater to the training. We decided to arrange a number of train-the-trainer workshops and agreed with case studies about the themes and tools for this training. At the GA at Hortobagy we presented a list of tools. Then we asked representatives of the case studies about their preferences, and from this list the decision was made which tools should be part of the training for which case study. All train-the-trainer workshops were planned to be arranged in 2007 and 2008. Figure 3 shows the concept for training and guidance as presented by WP 4.3 at the GA Hortobagy in 2006.
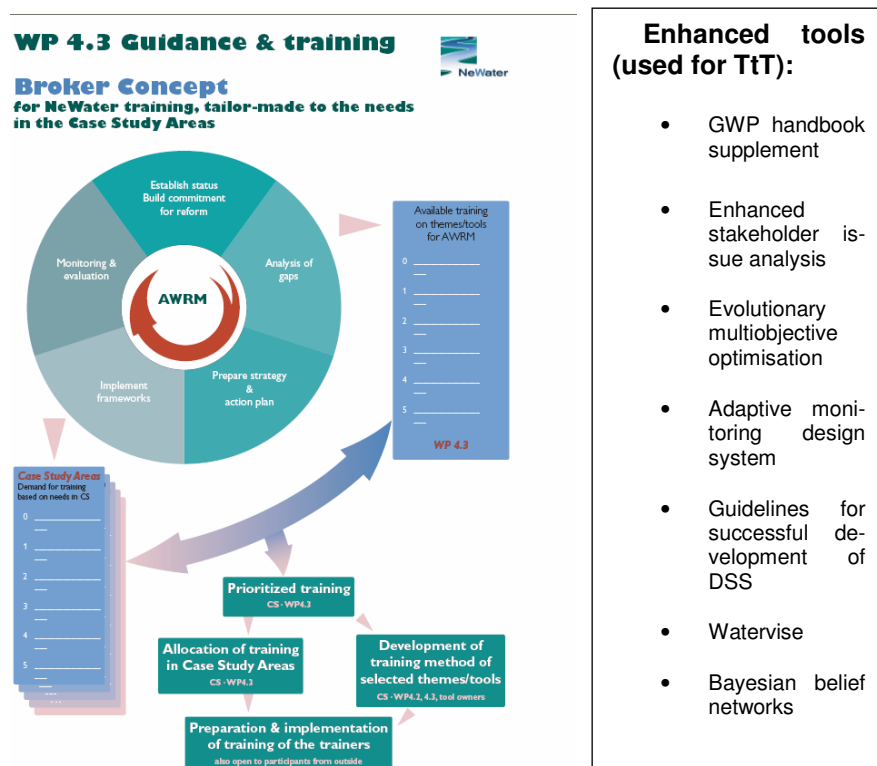

Figure 3 The broker concept. Training is based on demands from case studies. At the same time the train-the-trainer workshop provides the opportunity for empirical feedback to tool enhancement and dialogue (list of enhanced tools is indicated in the right column)

Added to this figure is shown a list of tools which have been fast tracked enhanced for AWRM, and as such available for training and guidance. After these clarifications, each river basin at Hortobagy selected 1-3 tools (see table 1).

3.5 Short description of tool enhancement

Within the NeWater project, the work package 4.2 focuses on tools and their enhancement to render water resource management more flexible and reflective. The enhancement is defined here as any improvement of the content, methodological background and transferability of a tool, or any other support measures which increase the users' ability to apply the tool (Mysiak et al., 2007). Since May 2006 the WP engaged in the fast-track enhancement of the selected tools for an early use in the NeWater case studies. The tool enhancements were carried out in collaboration with case studies. The enhanced tools comprise a wide variety of tools useful at various stages of the IWRM. The tools include (the abbreviations in bold are used throughout the document): The Bayesian Belief Networks for participatory integrated assessment (Bromley, 2005) and model building (**BN**) (Henriksen and Barlebo, forthcoming; Henriksen et al., 2007; Henriksen et al., in prep.); GWP Handbook supplement (**GWP Supplement**); Enhanced Stakeholder-Issue Analysis (**ESHA**); GANetXL software environment for genetic algorithms (**GA**), Farmani et al. (2007); Adaptive Monitoring Design Support System (**AMDSS**), Giordano et al. (Forthcomming); Guidelines for successful application of DSS (**DSS Guide**); and **Waterwise** - an optimisation, bio-economic model (Van Walsum et al., in prep.; Van Walsum et al., 2007).

These tools are useful at different stages of the policy cycle. The distribution of the enhanced tools' competences is well balanced: tools like BN, ESHA and AMDSS provide valuable insights into the management problem at hand and help to define its most salient features. Other tools such as BN, GA, WATERWISE are suitable at a later stage to assess effectiveness of policy options and to stimulate value judgements and building of consensus. Yet other set of tools (GWP Supplement, DSS Guide) provide guidance throughout the whole policy process.

The WP4.2 partners focused on various enhancements which included awareness rising and capacity building (GWP Supplement); better documentation (Waterwise, BN, GA), guidance in application of the tool (DSS Guide); novel approaches to the assessment of the tool performance by ex-post semistructured qualitative interviews of water managers (BN); improving the transferability of the tool or its results (Waterwise); making the

tools more flexible and applicable in context of adaptive management (ESHA, GA, AMDSS).

4 Testing in NeWater case studies

4.1 Train-the-Trainer workshops (TtT)

The TtT workshops had the content as described in Table 1 (Rotter et al., 2007). Three workshops have so far been held, four are being planned for by the end of 2007 and in the beginning of 2008.

Table 1: TtT workshops

Case study,	Block, theme, (theme owner), theme goal	Tool / owner/ tool description
Elbe, 3-4 May 2007	**Block 3 Prepare strategy and action plan** Theme: Use of Integrated Assessment (Alterra)	Tool: **Waterwise** (Alterra)
Guadiana, 5-6 September 2007	**Block 2 Gap analysis** **Block 3 Prepare strategy and action plan** Theme: Participatory Integrated Assessment (UnExe)	Tool: **Bayesian belief networks** (GEUS) Tool: **Evolutionary multi-objective optimi-sation** (Uni Exeter)
Amudarya, 14-15 September 2007	**Block 1 Establish status** Theme: Development of Stakeholder Commitment (Seecon):	Tools: Group Model Building / Cognitive Mapping (Seecon)
Rhine November 2007, **Tisza**, 2 days, be-ginning of 2008	**Block 1 Establish status** Theme: Stakeholder and Insti-tutional Analysis (TU Delft/ RBA)	Tool 1: Enhanced stake-holder issue analysis (TU Delft/ RBA) Tool 2: DANA, (USF)
Orange/Nile, Probably January / February 2008	**Block 4 Implement frameworks** Theme: Adaptive flexible Im-plementation Plan *(Cranfield)*	Tool: GWP Handbook Tool: ICIW (Alterra) Tool: Agile Project Man-agement Training

In several cases the test/application and the further development/enhancement are continued elsewhere in the project. This is important because the time allocated to the enhancement exercise was not always sufficient to guarantee a successful implementation of the tools in the case studies.

4.2 Experiences from Elbe, Guadiana and Amudarya

The Elbe TtT workhshop had the theme adaptive management and integrated assessment with the tool Waterwise. The overall impression was that the attendants were modellers who were more interested in the tool than in the adaptive management framework and the theme, but that the learning from this first workshop gave important feedback that should be addressed before the next TtT workshops. The discussions suggested a condensing of the AM general part with the many rather abstract concepts, and instead focus more where possible on issues and examples from the case study in order to make it more attractive and grounded and related to themes of interest for real world water managers.

The Guadiana TtT workshop had 20 participants. Workshop focus was on participatory integrated assessment. Sustainable management of irrigation and conflicts between farmers and conservationists is the main theme in the basin. The evaluation showed that some participants were less interested in adaptive management concepts and wanted to cover tools while others did not have background in NeWater. In balance we did well in meeting the needs of all. Participants expressed that they wanted more examples from their own case studies. More background information in advance of the workshop was also requested. Working with tools in advance and spending more time on them in the workshop would be helpful, participants told us. The workshop was generally rated as satisfying or very satisfying. However, the adaptive management presentation could have included more references to examples, practical applications etc. At a later WB4 meeting we evaluated that we in NeWater need to understand better the context of particular cases (we cannot and should not generically apply all our concepts and tools).

At the Amudarya TtT workshop it was discussed that this basin is a centralised state system with local water management boards. There is little bottom up influence. Salinisation is a significant problem; just as pesticides, fertilisers, etc; high level evaporation of irrigation water etc. Workshop focus was on adaptive management, participatory water management,

cognitive mapping (CM) and group model building (GMB). Only few of the 16 participants spoke good English so (non-simulation) translation had to take place. Additionally the presentations were translated in advance which was very helpful for the participants to follow the sessions. The workshop had a diverse audience: academics, PhDs, as well as people from outside NW – one GWP member, one ministry person. The participants were very interested to learn more about adaptive management and how it builds on IWRM, and the idea of participation and how to structure a process. In general expectations were very well met. The two methods taught were very positively received. However it will probably be difficult for someone for whom CM and GMB are completely new to teach it after one day of training, this is more awareness-raising. Though for those with some familiarity it is capacity-building and possible to teach others on the subject.

5 Discussions and conclusion

We started with an event at Mallorca listening to each other and developed the first ideas of tool enhancement in an interaction between researchers and practitioners from case studies, resulting in a diversity of ideas for tool enhancement organized as recycling, enhancement and testing of existing tools in case studies. Next we moved on to a dialogue, where we observed the current reality and selected tools of most potential for adaptive management and proceeded from there and in close interaction, fast track enhanced and tested seven tools, and hereby began thinking and forming new hypothesis about the value of adaptive tools, of linking tools, and of providing guidance for how to use tools more adaptively. This process went on until the decision on the TtT concepts / broker principle was taken at GA Hortobagy, and culminated at a joint session with case studies where interests in training blocks, themes and tools were decided.

After and based on deeper reflections in WB4 we established a room for connecting to the deeper source of knowing about adaptive management coming from researchers and practitioners in case studies. Based on this the idea crystallized that we needed a process of preparing TtT workshops targeted needs, and brought the broker concept into life. The deep reflection culminated at the TtT workshops and provided us feedback about needs for more general uncertainty guidance, and examples used for a handbook in AWRM. We also understood the importance of relating this guidance to the management and transition framework under development,

which could be implemented by applying our guidance-tools-and-training as a new adaptive management layer in the WISE RTD portal.

Then at the recent WB4 meeting in Leuven in 2007 we began creating new ideas for the development of prototype innovations of the portal. After evaluating the first three train-the-trainer workshops held in Elbe, Guadiana and Amudarya earlier this year, we realized that we had to reframe our toolbox, and instead of providing an all inclusive toolbox with AWRM tools, we instead decided to go for a handbook, that should provide examples of how to relate AWRM tools to the MTF developed and decided upon in July 2007. It also here became clear for us, that we needed to develop a new uncertainty guidance tool targeted for supporting water managers, policy makers and stakeholders in handling the 'ongoing efforts' needed for properly dealing with the uncertainties and complexities which are part of the planning cycle.

In the final part of the NeWater project, our challenge is to develop the larger innovation system, based on the new understanding of needs for guidance, tools and training, and upload our new knowledge base to the WISE RTD portal, including examples, tools and training which can be helpful for practitioners. The debated criteria for adaptive tools will here be of added value for water managers and stakeholders seeking for best practices about adaptive management, MTF guidance, tools for the processes and training.

AWRM builds upon IWRM. AWRM accommodates changes, uncertainties and complexity into scenarios for decision making. It attempt to build adaptive capacity to deal with unforeseen changes. AWRM leads to more decentralized infrastructure, and makes use of flexible monitoring and social learning. AWRM furthermore emphasizes the importance of stakeholder participation and requires open and innovative decision processes at various levels. We assume that AWRM tools, are transitional ones: it is a transition from a present management regime to a more adaptive regime; it stands for the effort to change water management. Although the tools from WB4 cannot change the regime, they can suggest and provide a necessary dealing with uncertainty, learning, and innovation. In line with this, the train-the-trainer workshops are transitional spaces, e.g. areas in which people hopefully will develop sounder better concepts about sustainable management of resources, and start learning new ways of managing their river basins and for transition to adaptive management. Stacey (2003) suggests that training and development is an important implementation tool, not only because it motivates people, but also because it provides the skills required for strategy implementation. The objectives of training and development programmes should be aligned with those of an organisa-

tion's strategy and those objectives should consist of measurable changes in corporate performance.

One of the questions which people may ask NeWater is how adaption and integration can be accomplished in the same move. Well they can. To find justification in the literature we have to look at Parson's AGIL scheme, which defines functions that need to be present in a social system, if it should be able to function. In the AGIL the "A" signifies Adaption, which is required in order to adopt and store resources from the environment, and the "G" signifies Goal-attainment, which is about how to use the resources in relation to a specific goal. Furthermore, the "I" signifies Integration, which is about preserving integrity of the system. Finally, the "L" signifies the Latency, which is the tasks, which structure a systems, identity and values.

Acknowledgement

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