NeWater

DELIVERABLE 422:
REPORT – SPECIFICATION FOR ENHANCING EXISTING TOOLS

Produced by WP42

Report of the NeWater project -
New Approaches to Adaptive Water Management under Uncertainty

www.newater.info

Title	Specification for the enhancement of existing tools
Purpose	This deliverable describes how and what tools have been selected for the enhancement in 2006. The enhancement is driven by case studies and aims at providing the case study teams with flexible tools encouraging reflexive management of water resources. The fast-track exercise aims also to learn how to specify, carry on and test the enhancements.
Filename	Deliverable 422 draft
Authors	See editor(s) and contributors (annex IV)
Document history	First draft
Current version	V1
Changes to previous version	-
Date	May 25 2006
Status	Final
Target readership	WB4 partners, case study teams
General readership	All Newater partners
Correct reference	Newater, Deliverable 422

Jaroslav Mysiak, editor
Fondazione Eni Enrico Mattei

May 2006

Prepared under contract from the European Commission

Contract no 511179 (GOCE)
Integrated Project in
PRIORITY 6.3 Global Change and Ecosystems
in the 6th EU framework programme

Deliverable title: Report on specification for enhancing existing tools
Deliverable no.: D 4.2.2
Due date of deliverable: Month 17
Actual submission date: 30.5.2005
Start of the project: 01.01.2005
Duration: 4 years

Executive Summary

Overview

Within the Newater project, the work package 42 focuses on tools and their enhancement to render water resource management more flexible and reflective. In the first project year the WP produced a state of the art report, conveying the potential and limitations of a variety of tools used in the context of Integrated Water Resource Management. The report, which draft version was discussed during the General Assembly in November 2005, focused on a number of different tools (such as uncertainty assessment, integrated frameworks, valuation, decision support systems, participatory processes) and toolboxes (e.g. GWP and Harmoni-Ca toolboxes). Confronted with the needs identified in the Newater case studies, the report indicates which tools should be enhanced in the first place.

The main task of WP in 2006 is the enhancement of selected tools in line of the identified needs in the case studies. This document discusses the structure of the specification and the meaning of enhancement. The enhancement is driven by case studies and aims at providing the case study teams with flexible tools encouraging reflexive management of water resources. The fast-track exercise aims also to learn how to specify, carry on and test the enhancements.

Tools enhancement

The enhancement of tools[1] has been extensively discussed during the GA in Palma di Mallorca (7-11.11.2005) and in Paris (8-9.2.2006). Summarising previous discussion, enhancement is 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. The specification of an enhancement consists of a list of actions, intended users and application context (envisaged purpose of the tool), and a time schedule. The WP42 partners agreed to specify the fast-tracked enhancement according to the following lines:

1. Name of proposed enhancement
2. Brief description of enhancement (what it involves and what it is aimed to deliver – 'gap')
3. Who is proposed to deliver the enhancement?
4. Timescales/effort for enhancement
5. Basin(s) that tool will be tested or used in
6. Detailed breakdown of each part of enhancement (for each part need to specify what input data may be needed, what needs to be done, what outputs will be produced, who will do the work and who will check and sign it off)
7. Details of how enhancement should be tested and how success will be assessed
8. Whether additional supporting material needs to be prepared (such as new user guide, training material, and who should produce this)
9. What would be required to apply the tool to more than just one case study basin?

Selected tools and gap addressed

The tools selected for the fast-track enhancement cover a variety of tasks and address a number of different, interconnected gaps. The tools are listed in Table 2 and detailed description can be found later in the sections 4.2.1 – 4.2.6.

The concept of adaptive IWRM is addressed by University of Cranfield. The GWP Handbook will be turned into more animated reading, supporting different learning styles and modes.

Role-playing game enhanced by TU Delft will facilitate an iterative and reflexive specification of the problem at hand. Combined with other tools such as interviews and desk studies, it will assist an in-depth analysis of the problem, including who is involved and whose viewpoints should be represented. On the other hand, the monitoring tool developed by IRSA will examine how the information needs

[1] Tools have bee characterised as guidelines, procedures, protocols, methods, techniques, an artefact, a device, an apparatus, and software programmes, used to support operational actions in performing IWRM.

are changing with increasing insights into the problem and the subsequent changes in the focus of the discourses.

The Bayesian networks (BN), addressed by GEUS, will be better documented. The enhancement focuses also on an improved assessment of the practical application, making the tool or lections learned easier transferable to different application contexts. The attention is paid to causal relations between numerous factors behind the problem faced.

Evolutionary optimisation algorithm, enhanced by UNIEXE, makes use of insights and knowledge gain from all previous tools. The algorithm will be improved to better account for a variety of different uncertainty sources and types. Similar in scope is also the enhancement addressed by FEEM, aiming to develop a guidance document of a successful application and development of DSS.

Alterra will focus on enhancement of the Waterwise model which is planned to be applied in several case studies also in other work packages. The model will be better documented and made easier transferable or adaptable to different application contexts.

Altogether ca. 10 person months are used for the fast track enhancement. This is enough to learn how to conduct later enhancement/development of tools but without wasting resources at an early stage of case study developments. Given the time and resources available for the fast-.tracking exercise, the preference was given to tools which the WP42 partners are familiar with. This is important since to keep the deadline for the delivery (December 2006), only a little time is available for learning and experimentation. The close links between the enhancement and the case studies on the other hand guarantees that the enhancement is driven by real needs and addresses gaps faced by case study teams.

On average the partners will use ca. half of the person months planned for the second 18m implementation plan. This corresponds on average to 1,6 PM/partner. The collaboration between partners enhancing similar tools or tools compatible in scope/purpose was encouraged but not characterised in this report.

Content of deliverable D423

It was agreed that the enhanced tools delivered by the end of 2006 will consist of:

– The tool itself – the fast-tracked tool (availability of the software has to be discussed with all developers, related to this is also the copyright/property right policy). In some cases (BN) explaining the commercial tool used may be necessary.

– Feedback for the training module – suggestions for the training material to be developed

– Progress report from the practical application of the tools in a case study (including a feedback from the intended users)

– Leaflets, posters etc. for dissemination activities. Should include information about how the tool has been enhanced and for what purpose it may be useful

Table of contents

1 Introduction

1.1 WP42 in the context of the project

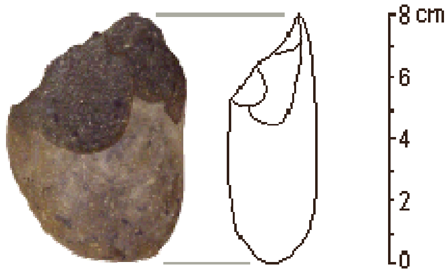
Within the Newater project, the work package 42 focuses on tools and their enhancement to render water resource management more flexible and reflective. In the first project year (2005) the WP produced a state of the art report, conveying the potential and limitations of a variety of tools used in the context of Integrated Water Resource Management. The report, which draft version was discussed during the General Assembly in November 2005, focused on a number of different tools (such as uncertainty assessment, integrated frameworks, valuation, decision support systems, participatory processes) and toolboxes (e.g. GWP and Harmoni-Ca toolboxes). Confronted with the needs identified in the Newater case studies, the report suggests which tools should be enhanced in the first place. The report identified a series of gaps, both in their methodological background and ability to address the complex management problems. These gaps will guide the tool enhancement which is the main objective of the WP in the 2006.

The **deliverable 422** explains how and which tools have been selected for the enhancement in 2006 and what are the addressed gaps. The enhancement will be carried out in collaboration with the case studies in the context of which the tools will be also tested. The tools found useful for the transition to adaptive management will be assembled in form of a toolbox which is the main outcome of the WB4.

The content of the specification is not given by the DoW. The proposal contained in this deliverable is based on an extensive discussion and agreement reached within the WP42. For the fast-tracked tools a priority has been given to tools with which the WP42 partners are familiar with. This is important since to keep the deadline for the delivery (December 2006), only a little time is available for learning and experimentation. The close links between the enhancement and the case studies on the other hand guarantees that the enhancement is driven by real needs and addresses gaps faced by case study teams.

1.2 Tools and why they need to be enhanced

Tools are as old as humans' ability to understand, change and adapt to the environment they live in. Figure 1 displays two examples of mechanical devices, devised in different ages, which are usually referred to as tools. But the term "tool" is not restricted to mechanical devices and encompasses different mediums.



Oldowan core tools - choppers[2] are probably the oldest, systematically used tools devised some 2.4 million years ago.

Deep Impact[3] - a space probe designed in 2005 to study the composition of the interior of a comet.

[2] See also http://www.handprint.com/LS/ANC/stones.html, accessed on 20.5.2006

Figure 1: Example of early stage tools (left) and recent high-tech tools (right)

Merriam-Webster dictionary[4] distinguishes two meanings, (i) a handheld device that aids in accomplishing a task; and (ii) instrument or apparatus used to perform an operation or necessary in the practice of a vocation or profession (e.g. book).

Different interpretations and classifications of tools and their uses exist. In the HarmoniCOP[5] project the information and communication (IC) tools encompassed any material artefacts, devices or software, that can be seen and/or touched, and which facilitates interaction between stakeholders through two-way communication processes. Tools were seen as distinct from *techniques* (way of treatment) and *method* (a procedure or process for attaining an object).

Tools to obtain information - Questionnaire(1)	**Tool for dynamic representations of reality, simulations** - Scenario tools(1) - Multicriteria analysis tool(1) - Simulation tool (2) - Spreadsheet (e.g. : Excel) - Decision Support System (2) - Integrated assessment model(1) (2)
Tools for static representations of reality - Maps(1) (2) (spatial representations) - 3D landscape scale model(1) - Information system - Geographic information system(1) - Conceptual model For (geographical) data base For systems dynamic - Cognitive mapping(1) (2) - Actors mapping(1) - Management of comments	**Interactive tools** - Interactive white board(1) - Internet Web information Forum communities Computer supported decision making Web mapping - Group Support System(1)
Gaming tools - Role playing game(1) (2) - Board game(1)	

Figure 2: Examples and classification of tools in the HarmoniCop toolbox

The GWP toolbox (see Annex 1) adopts a different connotation of the term which includes also policies (e.g. fiscal instruments) and organisations (e.g. river basin organisations). Obviously the definition of tools follows the intended purpose and the boundary between the tools, institutions, policies and epistemologies (e.g. adaptive management) are blurred and open to different interpretations.

In the Deliverable 421[6] the tools addressed in WB4 have been tentatively listed and encompass guidelines, procedures, protocols, methods and techniques, devices, apparatus and software programs. This list reflects different types of tools without the aim to provide a comprehensive classification. The different nature of tools implies different types of enhancements.

Different tools are not equally suitable for a specific situation. First, because they pose differ requirements (e.g. level of prior knowledge, input data, number of iterations, costs). Secondly, tools and the way how they are employed display affinity to attitudes and values

---

[3] For more detail see http://www.nasa.gov/mission_pages/deepimpact/main/index.html, accessed on 20.5.2006

[4] Merriam-Webster Online dictionary, available online http://www.m-w.com/dictionary/tool, accessed on 20.5.2006.

[5]

[6] State of the art pof

hold by those who apply them and subsequently survey distinctive perspectives/viewpoints. For example, those who apply monetary valuation of environmental services and goods implicitly accept the principles (e.g. trade-off is possible between different goods) and ethical standards (e.g. life can be monetary assessed) underlying this tool.

As a consequence, tools frame the problems, act as “lenses” through which the policy problem is viewed. Different tools thus may (frequently do) lead to different conclusions (results or recommendations). Associated to this is the resistance encountered by the application of some tools.

Tools furthermore differ in their complexity (simple vs. sophisticated, integrated tools), area of potential application (narrowly specialised tools vs. generic tools), and re-use potential and transferability. The quality assessment (also validation, verification, measurement of success) of different tools is not equally straightforward. Some tools such as conflict assessment/reconciliation, social learning or re-framing are difficult to measure as they regards subtle, intangible and incommensurable aspects such as changes in behaviour, level of trust and changes in relations.

Also, the benefits associated with a tool are usually multiple and the assessment requires that different aspects are weight against each other. In some cases the desired effect/achievement is yielded only by a simultaneous or consecutive application of several tools which poses another puzzle for the quality assessment.

The above discussion is important for the tool enhancement explained later in the section 3. To fit with the adaptive IWRM, the tools are (i) applied in a broader context (e.g. cost benefit analysis considering also environmental and resource costs); or (ii) modified to meet the new requirements (e.g. Decision Support Systems addressing the issue of change and institutional/organisational factors). Exceptionally a completely new tools have to be developed (e.g. integrated assessment models and scenarios). Therefore, the appropriateness of tools for a specific situation refers equally to the content (e.g. tool design) and the way tool is applied.

1.2.1 Gap analysis

Gaps to be addressed by the enhanced tools were analysed in del 421 and a gap report has been produced by HRW. The summary of the report are presented in the section 2. There are some limitations though which deserves special attention.

First, gap analysis requires that the goal or desired state is known and sufficiently structured to be attained. The adaptive IWRM which is aimed here lacks such an explicit and unambiguous understanding. The WP42 relies heavily on the input form the WB1 regarding the conceptualisation of adaptive regimes, and WP 17 in terms of the transition towards such regimes. For this deliverable all results produced in above context have been considered.

Secondly, in some case studies the basic management instruments (e.g. data and monitoring schemes for controlling groundwater quality) are missing. Consequently, the identified gaps do not refer to integrated and flexible management of water resources only. They reflect generic gaps preventing a sound management. Some of these gaps are associated with the lack of appropriate institutions.

Thirdly, the diversity of scientific practice (applied “lenses”) and lack of coherence among competing yet equally legitimate scientific methodologies may increase rather than reduce uncertainty and indecision. As Sarewitz [2004] puts it, nature is sufficiently rich and complex to support science enterprise of enormous methodological, disciplinary and institutional diversity. The quality assessment of science driven policy advises poses a fundamental challenge which has not yet been sufficiently resolved.

2 Summary of the gap analysis

2.1 IWRM Tools – Gaps between end-user requirements for tools and what is available at present

Gaps in knowledge, technique and application exist because "tools" are developed for specific purposes. Often the user has tailored the tool to the specific circumstances of the basin to address a specific need. Tools are primarily used to present options for action and to inform decision-makers. Tools are also used to demonstrate options to stakeholders and to get "buy-in". Tools are defined in the State-of-the-Art report but for most practical purposes are still thought of as being models (of any complexity).

There are many tools that can and do support IWRM; however wide use of tools is not evident. Is this because IWRM is not practiced or is it because there is still a lack of awareness of the need for IWRM? In both instances there is a need for training, probably better described as awareness building.

The gap between the existence of complex models and the requirements of an end-user for clear information on which to base decisions is real and is not likely to be bridged easily. The European Union has adopted a directive approach through the Water Framework Directive; however this approach may not be needed or acceptable in international basins outside of the EU. The HarmoniCA concerted action has attempted to address this and has also shown the wide divergence between the desires of water modellers (tool developers) and the requirements of decision-makers.

Table 1 is based on the "Gaps summary" table and the "Review of current IWRM practices in the Newater river basins" report. It includes users' requirements and gaps in existing tools that were observed in more than half of the case study basins. Further details about the general gaps (users' needs) in any particular basin can be obtained from the "Perceived needs" section of "Review of current IWRM practices in the NeWater river basins" report at the according basin description.

	Tools for	*Basins*						
		Rhine	Elbe	Guadiana	Tisza	Amu Darya	Orange	Nile
1	Close cooperation of all basin states (trans-boundary water management)	+	+	+	+	+	+	+
2	Development and implementation of IWRM policies (policies of more integrative and sustainable kind)	+	+	+	+	+	+	+
3	Engagement: participation modelling, stakeholders and public involvement techniques	+	+	+	+	+	+	+
4	Education: IWRM and AM concepts, public awareness			+	+	+		+
5	Information management: monitoring systems, collecting and analysis of real-time data, information sharing, integration of socio and economical data	+	+		+	+	+	+
6	Estimation of future uncertainties (climate change and socio-economic development) and their incorporation into the planning policies	+	+		+	+		+
7	Extreme events (droughts and floods) management: prevention, prediction, warning, actual crisis management	+	+		+	+	+	
8	Water quality management: monitoring, modelling and control	+	+	+	+	+	+	+
9	Effective groundwater management: integrated surface-groundwater models, legislation, monitoring and control		+	+	+		+	

Table 1: General gaps table

Complex doesn't necessarily translate into good or reliable. The needs of end-users (i.e water mangers) are dictated by the requirements of the political systems and institutions within the basins. Their needs are for reliability within acceptable bounds (acceptable probabilities). While tool developers have tried to make their tools more acceptable to water managers and stakeholders, greater complexity and sophistication and, what seems, rarefied language and concepts has increased the gaps.

The summary of the State-of-the-Art report recognises these problems and offers the solution of making professionals the users of complex tools and in involving water managers and stakeholders at a separate, later stage. The fear in the minds of the developers and professionals is that simplifying the system may result in knowledge being lost.

The gaps are likely to remain with tool developers, researchers and some professionals maintaining that models and tools to represent complex processes (hydrological and sociological) should be equally complex and thorough. On the other hand decision makers and their advisors of water managers (end-users) and stakeholders (usually acting as a group or NGO) want information that is clear, understandable, and reliable. The tool or model in this case is transparent. The reliability point is important and the end-user group needs to be confident that the tool(s) that have been used are founded on proper science and are tried and tested.

There is a clear role for improved training, capacity building, communication, awareness creation, demonstration through case studies and dissemination. Training interventions for end-users need to address the concerns of end-users, i.e. that they are the least important in the process. They need clear good guidance about what works now. Their other big need which will go some way to addressing the gaps is to provide "training" that enables end-users and stakeholders to specify the type of tools that they need. The demand for tools should come from end-users and not be research and supply driven as it appears to some end-users.

One of the common gaps in tools is linked to **data management systems**. The system needed should be able to collect data from different disciplines, information has to be dependable real-time and reliable. Databases should be on-line based with easy access and operation and shared between all basin states. In this case, the best practice can be taken from Elbe and Tisza basins.

XDAT is well organized, web-based database that collect real-time meta-data. Tisza River Information System (*TRIS*) allows efficient exchange of data and information between the countries sharing the river basin and can be a good example of trans-boundary data management system.

But there is still a problem of collecting and integration of different data types, such as results of questionnaires, interviews, focus-group investigations, any qualitative data, economical, social data, etc.

The problem of data management systems described above is directly connected to the **monitoring systems** enhancements, which are also were pointed out by most of the basin stakeholders. There is lack of coherent trans-boundary monitoring systems that provide reliable and necessary information for IWRM purposes. Emphasis should be done on groundwater monitoring systems that are less developed, especially in the third countries.

One good example of well established, well publicised ongoing programme is Monitoring, Forecasting and Simulation project (**MFS**) in Nile basin. This project includes development of integrated system of HAD reservoir management and can be enhanced in order to apply at a basin level.

Other tools that should be improved are **isotope monitoring** systems. This technique can be successfully used for groundwater monitoring.

Flood related issues were mentioned by most of the basin stakeholders. Improvement of tools for flood forecasting, prevention, warning and actual crisis management is of essential importance. In most of cases, flood problems are linked to climate change estimation and uncertainty analysis (including socio-economic development).

One of the best examples, is in use in the Tisza basin and is a coupled system of the **TISZA and TAPI** models. It allows investigation of the impact of different precipitation and climate scenarios on the Tisza water regime and development of flood-control scenarios.

The general problem of **participation modelling** and public, stakeholders and NGO involvement is of high importance for defining IWRM strategies.

Most of the basins require **trans-boundary water resource management** implementation. In this sense conflict resolution and close cooperation of all basin states are very important goals. Hydrology of the Rhine Basin (CHR) can be a good example of integrated basin model that supports basin management in a supra regional scale.

In general, there is the necessity of a **general framework** within IWRM that will integrate water, land, environmental, economic and social issues into basin development strategies.

2.2 Gaps according to the case study area

The following notes by John Bromley (CEH) are presented as an example of the gaps identified in three NeWater case basins, Amu Darya, Guadiana, and the Orange. Sources: Baseline reports from selected NeWater basins, stakeholder reports, RAPS, report D4.1.1 and draft report D4.1.2

2.2.1 Amu Darya

Overall there is a perceived need for new tools that assist in water allocation management. In particular there is a requirement for tools that provide accurate forecasts of run off, which impacts directly on the agricultural and water supply sector.

Currently there are no IWRM tools used in operative management or planning at the present time. (They are only used in a small number of scientific institutes). It has been stated that "the lack of management tools and efficient information systems and reliable databases has been to date a major constraint to progress in establishing a framework for Basin water management"

There is a need to handle the large amount of monitored data collected in the basin. Some water management organizations have departments, which work with GIS software and GIS databases. However GIS databases are not widely used in day to day water management because of a lack of trained personnel and finances).

Water allocations are estimated using Excel spreadsheets; allocations depend heavily on experience of operators. No model for the computation of water balances is available to the Ministry of Agriculture and water resources or the BVO. No up to date models capable of simulating water salinity. Salinity is not managed in the basin. Operational water management is commonly based on Excel spreadsheets; there is an urgent need for the introduction of new tools.

Computational models that have been evaluated: Automated system of run-off forecasting (ASRF), Mike11, (Mike21), WEAP, WAP, EPIC, WARMIS, RIBASIM, UNDP Model

Highest priority needs identified by stakeholders; tools are required to:

- Model and predict water quality (salinity) and sediment load on a Basin wide level
- Cope with high variability in river flow and to extreme events
- Facilitate transboundary water management
- Analyse ongoing institutional change, and the development of methods to strengthen new organizations and institutions
- Enable a more successful engagement of stakeholder in the political, cultural and social context of the Amudarya river basin
- Enables inclusion of the social dimensions of water management: poverty, gender and health

2.2.2 Guadiana

Needs identified by stakeholders; tools are required to:

- Develop more refined hydrogeological models (e.g. need inverse hydrological model based on newly defined aquifer geometries)

- Enable production of more educational material such as fliers, books, videos etc. Water education workshops? Also making material available to the public on the Web.
- Develop agronomic models to enable assessment of the economic implications of changes in future cropping patterns in response to the demands of forthcoming EU policies
- Track the extent of irrigated surface using remote sensing technology. Irrigation is a major water user in the Guadiana and it is essential for up to date accurate assessments of irrigated areas to be available to water managers. o
- To enable the accurate economic value of different crops and crop patterns. This is needed to decide on most sustainable use of the water available.
- Design effective groundwater monitoring network and to set up easily accessible data base which includes information about groundwater rights.

2.2.3 Orange

Suggest one major gap that NeWater should address: the development of future scenarios to promote the establishment of a common vision for the basin.

Specific suggestions for tool development include:

- Water Resource Planning and the Water Resource Yield model: The most important model applied is the Water Resource Planning and the Water Resource Yield models which are systems analysis techniques. These are re-run on an annual basis and used to consider a five-year time horizon. They are also used for scenario generation. These models include some aspects of water quality.
- Groundwater management models: A major information gap in the Orange basin is ground water. While some information is incorporated at a large scale it really only takes into account the impact of groundwater on surface flows. Even then, the relationship of ground water with surface water at the basin level is tenuous. Ground water information is very fragmented. Ground water also tends to be badly managed as it is often in the control of individuals, and thus tends to have a bad name.
- Yield models: The locally developed ACRU model has been widely used across the country including the Orange basin. This simulates flows based on rainfall and incorporates land use and condition etc.
- Water quality models: These are generally standard off the shelf models for reservoirs and rivers. They have been used in the past, but not commonly.
- Crop requirements: The SAPWAT model is used to calculate and forecast crop water requirements.
- Environmental Flow Requirements: The requirements for environmental flow are calculated using the locally developed Building Block Methodology, and the DRIFT method. Both these techniques have been widely used including for the setting of flows requirements for the river downstream of the Highlands project, albeit not without controversy.
- Ecological Reserve: As required by the South African Water Act, the Ecological Reserve has to be established for all major water resources. This has not yet been done at a detailed level for the entire Orange although the Vaal tributary is currently under investigation. A superficial “desktop” Reserve Assessment has been done for the entire basin within SA. The models that are used were developed by DWAF and are under constant revision.

- Social models: The Millennium Development Goals are taken very seriously and are the driving force for many activities in the basin, with firm commitments to achieve their aims. Tools to address poverty reduction in the water sector are needed, and tools to monitor progress towards the MDGs.

2.2.4 Rhine

Tools are required for following identified needs:

- To deal with uncertainties and to assess adaptive capacity: There are several directives that guide national and local water management and that are implemented under coordination of the ICPR (including WFD). However, these have not been taking into account future uncertainty (f.e. climate change and variability; socio-economic development), or include ways to anticipate it;
- Tools for quantity control: The tributaries of the Rhine generate most of its waters (Moselle and Main);
- Future management of the Rhine will ask for a close cooperation of all the basin states to establish a special river authority with powers to allocate the water-uses within the basin. Such future river basin management will be more a matter of all water users (including nature conservation) than of the respective governments;
- In the future, as diffuse sources of pollution form a growing part of the Rhine pollution issue, consultation at higher levels will become more important. In the context of the European Union, regulations for pesticide use must be introduced, and pollution originating from European-wide atmospheric deposition must be put on the other European agendas;
- Connecting hydrological models (both surface and groundwater) to policy making models;
- There is a need for research on what types of models are needed by the basin authorities to develop and implement policies of a more integrative and sustainable kind;
- In order to allocate water-uses in a dynamic way, dependable real-time information from all sectors and all parts of the basin should be made available;
- Developing systems for collecting data on basin level. In order to feed the above-referred models, an ever-increasing amount of dependable data is required. Research is needed to develop systems of dependable data gathering;
- Many basin wide problems require in depth studies, for instance on areas where flood prevention measures may yield substantial results;
- Plans or projects-approach: What strategy is the best for a river basin approach? Making an integrated policy plan for the whole basin and wait to see what happens or piecemeal working with projects for which impact studies have to be made;
- Stating lists of elements that spatial planners should include in their planning and plans. The interconnection between water management and spatial planning is gaining momentum. Need arises to provide spatial planners with checklists of provisions to be included into their studies and plans;
- Developing expert systems for flood management including warning systems, competent authorities for taking measures, flood prevention and action measures, and strategies for reservoir-management. Expert systems for actual crisis management should be developed;

- Water uses such as navigation, hydroelectric power generation, flood protection must be harmonized with environmental objectives, which means that they must be ecologically compatible and integrated.

2.2.5 Elbe

Tools are required for following identified needs:

- **Incorporating climate variability and climate change into IWRM**: The emphasis needs to be on water deficits and droughts. In the present climate, water is often scarce, with relatively low precipitation over the basin, and climate change is likely to be a considerable driver of increased vulnerability to droughts. It is likely to affect adversely several sectors, such as agriculture, forestry, water supply, navigation, recreation, nature conservation, and insurance;
- Joint Integrated River Management Plans: Germany and the Czech Republic still have differences in river management approaches. Integrated management plans for the total Elbe basin do not exist yet. The ICPE does have a comprehensive general Action Programme Elbe, which includes water quantity and water quality management, but this cannot be called an integrated management plan;
- Tools to control **water quality and ecosystem services**: Pollution of surface and groundwater is caused by the high intensity of water use, excessive application of fertilisers and pesticides, and domestic and industrial wastes. Although emissions from point sources have notably decreased since the beginning of 1990s, diffuse sources of pollution (mainly agriculture) are still not sufficiently controlled;
- **Transboundary issues**: Upstream and downstream water quality is important; the basin covers two countries, and there are many aspects where cooperation in relation to IWRM should be improved;
- Information provision: Enhanced exchange of information between water managers, stakeholders and citizens is important, since this information provision and involvement of the public is a prerequisite for successful implementation of measures;
- Strategy towards stakeholder involvement: Development of a strategy towards stakeholder involvement and interaction is required, since the mutual interaction between stakeholders groups is often still limited;
- Implementation of the WFD: This could potentially better empower the ICPE, since it would be carrying out programs in accordance with this higher, imposed, EC regulation. In this regard, the WFD could provide the basis for review of and intervention in shipping-related issues. Groundwater issues could also potentially be incorporated into ICPE research based on conformance with the WFD. The current redistribution of responsibilities among the state representatives will have a large impact on the overall effectiveness of the ICPE as an all encompassing managerial regime;
- NGO involvement: More open communication and involvement of NGO’s as well as the general public would be desirable.

2.2.6 Nile

Tools are required for following identified needs:

- Tools which incorporate **climate variability and climate change into IWRM**: The region, characterised by poverty, instability, rapid population growth, environmental degradation, and economies largely based on agriculture, is one which already suffers from high levels of variability in water resources (the key factor limiting water availability in many areas), and could be threatened by a reduction in precipitation due to climate change;

- Tools to control overuse of freshwater resources: Different levels of freshwater scarcity are experienced in the Basin depending on the population densities, the level of water development and water demand. Downstream riparian states are concerned about the call by citizens of the upstream riparian states to use some of the water resources flow to neighboring countries in projects that contribute to poverty alleviation in their countries;
- Water pollution: Water quality is highly variable, from place to place and from time to time, even within a particular river system. Water pollution in the basin is associated with suspended solids, micro-biological, chemical (agricultural and industrial), eutrophication and solid waste disposal thermal pollution. The level of pollution increases with population densities and urbanisation, level of irrigation return flow, and level of industrial activities. Major preoccupation is with water quantity and not water quality as such not enough attention is given to water quality issues such as monitoring, pollution control and prevention;
- Lack of adequate information and knowledge: Most of the technical data in all Nile basin countries are available such as, meteorological, hydrological, water use, and food production. Although most of the Nile basin countries have undertaken analyses of the Nile, the quality of the data is very mixed and it is impossible to draw any detailed accurate overview. The water monitoring of the Nile by each country is also variable and there needs to be a consistent simple approach for the trans-boundary monitoring, whilst each country will need to expand for the national monitoring;
- Also in the absence of adequate information, stakeholder participation is constrained;
- **Reservoir management:** Some 85% of the total Nile discharge originates from the Ethiopian highlands. Ethiopia has decided to increase its irrigated area through building new dams, which will have impacts on downstream users already facing water shortages. On the other hand, the various water storage reservoirs in the region suffer from very high evaporation losses, which could be brought down by improved management. All these issues have strong transboundary aspects and require an IWRM-linked approach;
- **Water quality and ecosystem services:** Water quality issues are critical, particularly in the downstream heavily populated and more industrialised areas, while erosion due to deforestation and poor land management is a severe problem in the highlands, where the use of an ecosystem services approach which links land management to water availability needs to be investigated;
- **Poverty alleviation and gender issues:** These are major factors in vulnerability in the basin, and new approaches which integrate these perspectives into water management are needed;
- **Dissemination, training and awareness raising:** are of vital importance, with a need to strengthen awareness and capacity to undertake IWRM approaches and to integrate them into development plans and management across economic, social and environmental sectors;
- The Nile Basin policy framework is characterized by poor policies and/or inability to translate policy statements to action: Of particular concern are property rights

policies and other policies that provide incentives for efficient water use, which are so critical in promoting individual investments in resource conservation;

- Public involvement in policy formulation, particularly in water policy has been limited: Most water stakeholders are not aware of the water policies and how they affect them. Most countries lack policies that promote water conservation at the user level;
- There is inadequate legislative framework for supporting good, fair and equitable water management in most countries. Many water laws are violated leading to high levels of illegal water abstractions and water pollution;
- Despite the many cooperative agreements, it should be stated that most of the Basin countries are burdened by weak human and institutional capacity to manage water resources in an integrated manner. This situation applies not only to the management of international waters, but also to the management of national waters. That is, water management within each country is still fragmented between sectors, and there is little integration among various sectors of water use, between water quantity and quality, and between surface and groundwater.

2.2.7 Tisza

Tools are required for following identified needs:

- **External (supranational) policies and directives:** The difficulties are connected to the introduction of European initiatives and documents at the local and regional scale. An effective system for exchange of information and data is also needed;
- **Climate variability and change:** Disastrous flooding has become more frequent due to the felling of forests in the Carpathian mountains; a programme of forest rehabilitation and erosion protection measures is needed;
- Protection of human lives and properties in relation to the floods: through identification of the necessary and most cost-effective principal remedial actions to protect human lives and properties through the minimisation of environmental risks, including environmental hotspots, flood control and prevent flood damages. These may include long-term management of old tailings deposits, the reopening of certain wetlands to periodic flooding, and additional protection measures for threatened settlements;
- Enhanced information management: by using a combination of satellite imagery and traditional monitoring measure to provide a picture of the river basin that can be accessed by the public on the Internet or through local or sectoral authorities and NGOs;
- Increased public awareness: specific emphasis would be on access to information through local media such as newspapers and TV stations, or through specific publications accessible to the broader public;
- Increased space for public policy dialogues at local, national and regional levels to ensure effective public participation in decision-making and monitoring & evaluation;
- Institutional arrangements: focused on the harmonisation of legislation within the TRB; the creation of an international institutional body with country based representation and involving powerful NGOs and/or a special implementation agency; and the development of administrative capacities at local level;
- The creation of development mechanisms that encourage bottom-up processes in project identification and reflect local development needs; the use of common

structures, models and approaches to project management; the identification of criteria for the setting of priorities; and the definition of indicators for project appraisal were identified as the key elements in programming and related project management.

- The issue of cooperation was focused on at different levels and with regard to several aspects: the encouragement of international cooperation; the raising of interest in using mechanisms to solve problems at their roots and not at the end of the pipe (see floods and embankment lifting, or reforestation at the watershed issue); the development of cross-sectoral cooperation, especially between the business and NGO sectors; cooperation within the business sector to fill the gap in traditional economic practices; increased cooperation between regional offices in the TRB; and finally the strengthening of scientific cooperation regarding the TRB through an international scientific conference;
- There is a need for conflict management and to build trust: by for example providing capacity building through counseling;
- No Inter-Ministerial (Sector) Coordination: there exists some inter-ministerial competition for authority. The use of regional strategies or agreements could reduce these internal problems and enable transbounday success;
- Lack of capacity at local authority level: it will be necessary to build capacity and use best practice within catchment;
- Lack of information exchange: this could be improved by speeding up the information flow; setting up a meta-database; the use of information experts to analyse information; the ability to derive knowledge from information; and finally to establish an information centre;
- Lack of sufficient funds: with finance availability, these funds often has to be channeled through central government;
- No clear boundaries between national and regional responsibilities;
- Lack of retention in the catchment, leading to need for disaster prevention measures;
- No clear framework for action and setting up opportunities for whole Tisza catchment with sector groups for each of water, agriculture, rural development etc;
- Lack of incentive-based approach to encourage positive contribution to good catchment management and harmonisation of trans-boundary incentives for wise use of land;
- **Water quality issues:** Problems of water quality are mainly linked to industrial activities and transport. Annual flooding and serious water contamination are the most relevant issues. The development of transboundary measures on the reduction of pollution inputs and the introduction of international indicators for water quality and condition of ecosystems is needed;
- **Surface and groundwater storage facilities:** The elaboration of a programme of sustainable balanced water use and consumption at local and regional scales, most of all with respect to the transboundary situation, is needed;
- **Transboundary institutional and political issues.** The organization of a permanently acting international seminar for discussion of transboundary institutional and political issues of water policy is needed;
- **Transition from demand/control water resources management to adaptive water management practices.** Transition will be carried out based on the relevant

existing institutional structures, as well as NGOs. Adaptive water management has to engage with the probable effects of new approaches to transboundary problems.

3 Specification of the enhancement

3.1 Definition

The enhancement of tools has been extensively discussed during the GA in Palma di Mallorca (7-11.11.2005) and during the WB meeting in Paris (8-9.2.2006). Summarising the discussion, enhancement is considered as an improvement of the content, methodological background or transferability of a tool, or any other support measures which increase the users' ability to apply the tool.

Methodological background: A tool is associated with a theory; methodology, and a set of implicit assumptions, which can all be summoned up to an epistemological framework. For example, the participatory approaches to environmental management refer to deliberative democracy (distinct from representative democracy) and right of people who are affected by a decision to have their say. It is close to *constructivist epistemology* which considers knowledge as contingent on convention, human perception, and social experience (thus "constructed").

On the other hand the Cost Benefit Analysis (CBA) is grounded in the welfare economics and utilitarian philosophy. It assumes that the policies should be valued on the bases of their consequences (not compatible with right-based approach). Other assumption is that a policy is welfare improving for a society if the gainers could compensate the losers and still be better of. The related epistemological framework is that of neoclassical economics. In this context, the adaptive management and integrated resource management are epistemological frameworks (or guiding principles), rather than single tools.

Transferability means the ability to use a tool in a different context than that for which it was originally conceptualised or validated/tested. In the new situation the required input data may not be available or refer to different temporal and spatial scale. The enhancement in this context means an adaptation of the tool to the new situation, without compromising the underlying methodological background. Transferability may also refer to the results yielded by a tool. For example value transfer means that the values associated with e.g. wetland functions on a certain location are derived from the analysis of other studies of the same functions carried out somewhere else.

Support measures refer to the documentation, tutorials, interfaces and demonstration examples of the tools, facilitating their application in specific situations. Other actions relate to rising awareness/interest and maintaining the commitment of users.

<u>EXAMPLES OF ENHANCEMENTS</u>

- Adding a new functionality to existing tools, e.g. a new segmentation-based classification algorithm in a software for image analysis.

- Critical investigation of the underlying assumptions of a tool and improvement of their methodological design. Example: Analysis of the reasons for a persistent lack of the successful implementation of the DSS.

- Making the essential beliefs explicit and transparent. Example: Exploring the validity of a tool in different situations.

- Relaxing the assumptions and broadening the compatibility with other tools. Example: Combination of preference elicitation techniques with participatory approaches.

- Relaxing the input requirements of the tools. Examples: Adaptation of existing models in specific situations where some of the input data is not available. Development of metamodels.

- Transfer of results obtained form the application of the same tool in different situation. Example: Value transfer.

- Users' understanding of the tool. Example: Demonstration examples, tutorials, handbooks, teaching courses.

- Tools dissemination or accessibility. Example: Development of a portal.

- Linkages between the tools and tool packaging. Example: Development of toolboxes.

3.2 Elements of the specification

The specification of an enhancement consists of a list of actions, intended users and application context (envisaged purpose of the tool), and a time schedule. The WP42 partners agreed to specify the fast-tracked enhancement according to the following lines:

10. Name of proposed enhancement
11. Brief description of enhancement (what it involves and what it is aimed to deliver – 'gap')
12. Who is proposed to deliver the enhancement?
13. Timescales/effort for enhancement
14. Basin(s) that tool will be tested or used in
15. Detailed breakdown of each part of enhancement (for each part need to specify what input data may be needed, what needs to be done, what outputs will be produced, who will do the work and who will check and sign it off)
16. Details of how enhancement should be tested and how success will be assessed
17. Whether additional supporting material needs to be prepared (such as new user guide, training material, and who should produce this)
18. What would be required to apply the tool to more than just one case study basin?

3.3 The final form of the enhanced tools:

It was agreed that the enhanced tools delivered by the end of 2006 will consist of:

– The tool itself – the fast-tracked tool (availability of the software has to be discussed with all developers, related to this is also the copyright/property right policy). In some cases (BN) explaining the commercial tool used may be necessary.

– Feedback for the training module – suggestions for the training material to be developed

– Progress report from the practical application of the tools in a case study (including a feedback from the intended users)

– Leaflets, posters etc. for dissemination activities. Should include information about how the tool has been enhanced and for what purpose it may be useful

4 Selection of tools for the fast-tracing exercise

4.1 Summary

The tools selected for the fast-track enhancement cover a variety of tasks and address a number of different, interconnected gaps. The tools are listed in Table 2 and detailed description can be found later in the sections 4.2.1 – 4.2.6.

The concept of adaptive IWRM is addressed by the tool No. 2, dealt with by University of Cranfield. The GWP Handbook will be turned into more animated reading, supporting different learning styles and modes.

The tool No. 3 and 5 are similar in aim but address different tasks. Role-playing game enhanced by TU Delft will facilitate an iterative and reflexive specification of the problem at hand. Combined with other tools such as interviews and desk studies, it will assist an in-depth analysis of the problem, including who is involved and whose viewpoints should be represented. On the other hand, the monitoring tool developed by IRSA will examine how the information needs are changing with increasing insights into the problem and the subsequent changes in the focus of the discourses.

The Bayesian networks (BN), addressed by GEUS, will be better documented. The enhancement focuses also on an improved assessment of the practical application, making the tool or lections learned easier transferable to different application contexts. The attention is paid to causal relations between numerous factors behind the problem faced.

Evolutionary optimisation algorithm, enhanced by UNIEXE, makes use of insights and knowledge gain from all previous tools. The algorithm will be improved to better account for a variety of different uncertainty sources and types. Similar in scope is also the enhancement addressed by FEEM, aiming to develop a guidance document of a successful application and development of DSS.

Alterra will focus on enhancement of the Waterwise model which is planned to be applied in several case studies also in other work packages. The model will be better documented and made easier transferable or adaptable to different application contexts.

No	Tool	Partner	PM	Test basin	Enhancement
1	Bayesian Network for participatory modelling	GEUS	2,5	Guadiana or Rhine or Orange	Documentation and ex-post assessment of the Zealand case
2	UN-GWP Handbook	CRAN	0,5	Orange and Rhine	Integration of various learning styles and preferences in a new interpretation and delivery of the handbook
3	Enhanced Stakeholder-Issue Analysis	TU-DELFT		Tisza or Guadiana or Amudarya	Adjustment to adaptive management
4	Evolutionary multiobjective optimisation	UNIEXE	1,5	Guadiana and another basin	Generate management scenarios, explore the trade off and address uncertainty
5	Adaptive Monitoring Design Support System	IRSA	2	Tisza and Amudarya	Information needs elicitation to take into account the continuous changes
6	Guidelines for DSS	FEEM	3	Tisza	Key success factors for implementation and development of DSS
7	Waterwise model	ALTERRA	1	Rhine	Transferability and documentation

Table 2: Tools selected for fast-track enhancement and delivered by December 2006

Altogether around 10 person months are used for the fast track enhancement. This is sufficient to learn how to conduct later enhancement/development of tools, without employing too much resources at the early stage of the case study developments. Given the time and resources available for the fast-tracking exercise, the preference was given to tools which the WP42 partners are familiar with. This is important since to keep the deadline for the delivery (December 2006), only a little time is available for learning and experimentation. The close links between the enhancement and the case studies on the other hand guarantees that the enhancement is driven by real needs and addresses gaps faced by case study teams.

On average the partners will use ca. half of the person months planned for the second 18m implementation plan. This corresponds on average to 1,6 PM/partner. Only CRAN has employs less than 1 PM which is a conservative assessment which may exceeded in practice. CRAN was given extra resources for the WP42 only recently and did not want to raise expectations too high before examining the practical suitability of the proposed enhancement.

The collaboration between partners enhancing similar tools or tools compatible in scope/purpose was encouraged but not characterised in this report.

4.2 Detailed description of the tools to be enhanced

4.2.1 Bayesian Network (Bn) for participatory modelling

Brief description of enhancement

The BN as developed in the EU – FP5 project MERIT (www.merit-eu.net) was based on an assessment for the consequences of pesticide leaching to groundwater in northern Zealand (Denmark) with full stakeholder engagement. The enhancement is about documenting and clarifying the value of the tool compared to the value of the process in the Zealand case and relate the guidelines which was an outcome of MERIT from four case studies throughout Europe to IWRM with AM in order to provide an enhance BN/MERIT tool applicable for other Newater case studies as a general tool for decision making with active involvement of stakeholders as a participatory modelling tool.

The Bn procedure promotes transparency, awareness raising and a high degree of stakeholder involvement in the decision making process, and explicitly takes uncertainty into account in a practical way. Bns used with active involvement are useful for movement in local situations, dealing with paradoxes, simultaneous continuity and transformation, and participation in subjective interactions in groups with meaning in the living present.

Timescales/effort

After Action Research (AAR) workshop, including review of Bn process in retrospect with participation of water manager (June 2006 workshop). Qualitative, semistructured interview and interpretation and resubmission of paper to Journal of Environmental Management.

Development of enhancement based on these efforts in late Fall 2006. For collection and transcription of empirical data from workshop, and analysis and interpretation, and resubmission of AAR paper to JEM will be needed 1 man-month. Subsequent work in fall 2006 with relating guidelines and inclusion of tool enhancement as a method will be needed 1-2 man-month (2-3 PM in total).

Test basin(s)

Not determined yet, optionally in Guadiana, Rhine and Orange. Will be decided after the June AAR workshop.

Detailed breakdown of each part of enhancement

a) Qualitative interviews with end-users on where the Bn has been applied as part of AAR. Here it will be analysed whether use of the Bn software isolated or the entire procedure including use of Bns (MERIT guidelines, in prep), or both, has lead to successful implementation.

b) Assessment of Bn tool applicability and suitability in the Adaptive Management process as developed in Newater.

c) Development of generic documentation for the use of Bns in PP and make it easily adaptable for case studies. The documentation must also fit into the Portal infrastructure in order to make it accessible for stakeholders.

d) Documentation in coordination with WP4.3 guidance and training.

Details of how enhancement should be tested and how success will be assessed

Enhancement is to be tested in optionally Guadiana, Rhine (Kromme Rijn) and Orange.

Additional supporting material needs to be prepared

No user orientated documentation for the Bn case exists and needs to be developed from scratch. GEUS will provide this. Refer to (6)

What would be required to apply the tool to more than just one case study basin?

A generic, easily adaptable documentation and development of guidance and training material is needed in the first place. Then the documentation and guidance and training material must be tailored to the specific needs of the case studies. For example, the original Bn case study developed in MERIT for the Zealand case is on consequences of pesticide leaching to the groundwater. For applying Bn to other cases, the Zealand case documentation must be adapted to become a generic one and subsequently tailored towards specific needs in other case studies.

4.2.2 UN-GWP Handbook

Brief description of enhancement

The current UN-GWP handbook, "Catalyzing Change: A handbook for developing integrated water resources management (IWRM) and water efficiency strategies", is a text based tool of 51 pages, delivering content on: the IWRM concept (basic principles, advantages, and implication for water governance); guidance on choosing an entry point into the strategy development process and on defining core issues and reforms the strategy needs to address; issues of managing a strategy development process; and, suggestions for ensuring effective implementation and change. While there are a few tables and figures with bullet point information, and the style of writing is very engaging, the delivery of the material overall is very dry. The current tool makes use of only one of predominant 6 learning styles and preferences (visual text). Therefore the proposed enhancement is to integrate other learning styles and preferences in a new interpretation and delivery of the tool.

In addition, while the current UN Handbook provides concise and valuable information for managers, it does not articulate this in the context of their own experiential learning process. To enhance the current tool to improve its delivery in this area, it will be necessary to adapt it according to Kolb's learning cycle. Also, the UN Handbook lacks a context of delivery in terms of technological means and social context. The state of the art in learning tools and methods puts the spotlight on these two predominant areas: technological means; and, social contexts of learning. Over and above these two areas are the ways in which learning is enabled by either technological means or within the social context. Finally, as previously stated in earlier deliverables, IWRM is not informed by AM and this needs addressing in this tool.

Timescales/effort

Cranfield has an allocation of 0.5 person months for this task. Other person months as appropriate from other contributing partners. We will be happy to receive input and ideas from other partners – in particular in reference to turning any paper ideas into ICT tools.

Test basin(s)

Orange and Rhine. Comparative case study data is considered beneficial - therefore minimum of 2 basins.

Detailed breakdown of each part of enhancement

a) Analyse and deconstruct current tool/workbook

b) Outline essential content for delivery to target end users

c) Synthesise results with previously synthesised IWRM & AM concepts & relevant metaphors once identified (possibly from complexity science).

d) Package results into 5 (plus or minus 2) key themes/principles, with sub themes/principles where necessary (again, 5 plus or minus 2)

e) Package these principles into a NAM (NeWater Adaptive Management) 'Starter Kit', where this NAM Starter Kit facilitates learning and development of water resource management practitioners in state-of-the-art AM know-how and practical implementation techniques.

f) Design content and format of the NAM Starter Kit to address each of Boyle's (2005) 6 main learning styles and preferences (audio; visual text; visual picture; tactile; kinaesthetic; verbal kinaesthetic) according to Kolb's Experiential Learning Cycle, to be implemented through a balanced mix of learning facilitated in social and technological contexts.

g) This will be articulated and introduced initially as a paper-based tool but would ultimately seek to include a balance of workshop and ICT tools later.

Details of how enhancement should be tested and how success will be assessed

While this has yet to be defined in detail, it is possible to state that, broadly, evaluation will be made on a comparative basis through user-based assessment of the old tool (the UN Handbook) and the new tool (the NAM Starter Kit). The tool will be implemented at the case study sites mentioned, in addition to the UN Handbook being made available. The overall aim will be to carry out evaluation with two case studies and a control group. This will be broken down into phases. Indicators of success could, for example, relate to the number of new initiatives started/planned as a result of the intervention.

Additional supporting material needs to be prepared

This will be forthcoming in line with point 6 above. Cranfield will be responsible for producing this but may seek the help of other interested parties within the consortium.

What would be required to apply the tool to more than just one case study basin?

Willing participants, their time and engagement in the effort.

Ideally: 2 groups of five middle managers from each case study site.

4.2.3 Enhanced Stakeholder-Issue Analysis

Brief description of enhancement

A role game will be developed to be used for stakeholder and issue analysis. Already a lot of role games exist, but these do not include issues of adaptive management. The purpose of the role game will be to provide further insight in the stakeholders and the issues at hand (stakeholder goals, interests and aims). This insight is essential for putting adaptive management into practice. Insight will be gained in how stakeholders at present manage their water resources and what changes may take place in this management when confronted with social, environmental or economic changes.

Different methods for stakeholder analysis already exist, such as interviews, document study, etc. Role gaming, however, enables the researcher to study interaction patterns between the stakeholders. Moreover, by participating actively, the stakeholders themselves learn a lot about each other, their points of views, their issues of concern and the manner in which they interact.

Timescales/effort

Test basin(s)

The basins that are considered at the moment are, the Tisza, the Guadiana and the Amudarya. Information about these basins will be gathered, contacts will be sought and the choice will depend on the context and situation which best lends itself for the proposed enhancement.

Detailed breakdown of each part of enhancement

a. The relevant situation and (economic, technological, social) context in which the enhancement is to be tested will be described;

b. Success criteria and indicators will be specified;

c. Based on a. and b. the (more) relevant aspects of present games to use will be decided upon;

d. A prototype will be designed;

e. The prototype will be tested in the basin;

f. Testing will be evaluated (by game designers and stakeholders);

g. Adjustments will be made and the game fine-tuned (by game designers)

h. Advice will be given for use in other basins.

Details of how enhancement should be tested and how success will be assessed

Testing should be done with relevant stakeholders. It is thought to separate stakeholders in three categories; the decision-makers, the scientists (ie. engineers) and the local water-users. However, this will also depend on social context in the basin. By having these three groups role-play, insight can be gained as to how local water-users and decision-makers view water resources technology as well as how the success (or failure) of technology can be influenced by water-users and decision-makers in the particular setting. Scenarios could be played out to gain insight (for all parties) into how the other stakeholders might react when climate changes, populations rapidly change, or economies change.

Additional supporting material needs to be prepared

In order to develop the game, a more detailed background description of the relevant basin will be needed (though this is most likely already available from the other studies done). Also, a detailed map of the area and the water resources there within will be needed, which most likely is also available.

What would be required to apply the tool to more than just one case study basin?

This is one of the most important aspects of the enhancement: to make the game applicable to other basins. However, how to do so will depend on the experiences from testing and from lessons learned by others who have worked on other types of games.

4.2.4 Evolutionary multiobjective optimisation

Brief description of enhancement

Our existing evolutionary multiobjective optimisation code can be applied for generating different management scenarios, the trade off between different objectives and also for sampling in order to address uncertainty in decision making process. This will require some modification. In addition the algorithm needs to be further developed to be applied to adaptive management of water resources.

Enhancement of Evolutionary multiobjective optimisation algorithm in order to address interactive decision making by introducing flexibility and reversibility of decision in the decision making process.

As far as we are aware, optimisation algorithms in general and evolutionary algorithms in particular, have not been applied to water resources management. As evolutionary multiobjective optimisation will generate a number of solutions in a single run, it will give the decision makers choice among alternatives. The main enhancement will address the adaptive nature of the decision making process, where decision tree will evolve as learning takes place.

Timescales/effort

Some preliminary work on the code will before July/August but the work on the enhancement will start after the Guadiana river basin problem structure was made available.

Test basin(s)

Guadiana and/or another basin

Detailed breakdown of each part of enhancement

The evolutionary optimisation code will be changed to address the adaptive nature of the decision making process, where decision tree will evolve as learning will take place.

Details of how enhancement should be tested and how success will be assessed

Enhancement can be tested against benchmark problem(s) and after validation will be applied to the Guadiana river basin.

Additional supporting material needs to be prepared

UNEXE will develop training material as part of task 4.3

What would be required to apply the tool to more than just one case study basin?

Appropriate documentation and training material; familiarity with problem setting, preparation of input file and the format of the output file.

4.2.5 Adaptive Monitoring Design Support System (AMDSS)

Brief description of enhancement

Adaptive management is essentially about learning, adapting to changing conditions and anticipating on possible changes. An adaptive monitoring system should therefore be inherently flexible and able to adapt to changes. Next to that, water monitoring should be an integral part of the water management process as well as the water governance process. Among the several methods that have been developed to support the information needs definition, we focus on the information needs hierarchy (Timmerman and Mulder, 1999). This method provides a five-step plan that enables managing the information needs definition process.

During monitoring, targets may be reached or policies may change, implying that the monitoring strategies may be adapted. Moreover, feedbacks are acquired about the performances of the monitoring program with respect to design, technical issues and evaluation. The information users’ perspectives may change, influenced by the evolving knowledge of the participants of the issues at stake through the learning process, resulting in new information needs. Therefore, information needs are not static, since they change during the decision process, i.e. the information required depends upon the stage in the policy cycle. Each information need poses specific requirements to the monitoring system in terms of performances, methodologies and evaluation and presentation of data.

The difference between the traditional approach to monitoring design and an adaptive approach is that in the adaptive approach the barriers to monitoring design are overcome by adaptively implementing monitoring rather than waiting for new information or designing a system that does not anticipate new information.

Thus, the aim of the IRSA contribution to the WP 4.2 concerns the definition of a System able to support the Adaptive Monitoring Design (AMDSS). This system will enhance the potentialities of the information needs hierarchy, taking into account the dynamics of the processes influencing the information needs.

Timescales/effort

2PMs

Test basin(s)

The proposed enhancement will be tested in coordination with the experimental activities of the WP 1.6, dealing with the definition of an Adaptive Monitoring Information System. Thus, the enhancement will be mainly tested in the Tisza and Amudarya basins.

Detailed breakdown of each part of enhancement

- **- Construction of the knowledge base**: the knowledge contained in the web catalogue, developed by WP 1.6, will be structured in rules (if…then) and stored in the knowledge base module. The rules will be applied to support the user in the information needs definition. The suitability of Fuzzy Logic to structure the knowledge will be evaluated.
- **- Definition of a methodology to support the *individual* learning process**: an in-depth review of the scientific literature dealing with the learning process in decision-making will be carried out. The concept of "value of information" seems particularly interesting.
- **- Definition of a methodology to support the *collective* learning process**: an in-depth review of literature regarding the awareness of the different agents and the creation of a community of interests will be carried out. In this phase, a method will be provided to support knowledge exchange among stakeholders.
- **- Definition of a methodology to support the Adaptive Monitoring design:** evaluation of the internal factors (efficacy indicators, etc.) and external factors (suggestions for each policy stages, etc.) influencing the iteratively definition of information needs

Details of how enhancement should be tested and how success will be assessed

In these CS, due to the difficulties with the ICT, the attention will be mainly focused on the individual learning process. More in detail, the enhancement will be tested in different phases:

- Information needs definition: the information needs will be defined according to the Information Needs Hierarchy method, adapted to the CS peculiarities. A participatory approach involving the local stakeholder will be adopted. A method to cope with different and often conflicting aspects will be integrated in the information needs definition.

- Supporting the individual learning: the methodology to support the individual learning will be preliminary tested in an experiment. This phase is needed to improve the methodology since the evolution of information needs is a slow process. The results of this experiment will be used to define the methodology which will be used to lead the learning process in the CSs.

- Supporting the collective learning: for the same reasons, the methodology to support the collective learning will be preliminary tested in an experiment with a web-based forum.

Additional supporting material needs to be prepared

Since the tool enhancement is mainly based on the interaction with the information system users, it's fundamental to include a user guide in the user interface. This guide should explain the importance on information needs in the design of a monitoring information system, and the different steps. Examples can be included to lead the user in defining the information needs. This guide will be produced contextually with the user interface.

What would be required to apply the tool to more than just one case study basin?

The methodologies at the basis of the tool enhancement are generally valid, and are not linked to the site conditions. Nevertheless, the tool enhancement can include the web-interaction only in CS characterized by a wide diffusion of the ICT. In other basins, the methodologies can be applied to a "traditional" group interaction.

4.2.6 Policy Guidelines for Decision Support Systems development and application

Brief description of enhancement

The Decision Support System is a buzzword attracting immense attention, unwarranted enthusiasm and, frequently, disillusion and misleading criticisms. The guidance document will "disenchant" the concept and convey its potential and limitations which are likely to encountered in practical applications. The guidance will inform the choice of a system, assisting policy makers in specifying their needs and forming reasonable expectations. The guidelines will make use of a broader literature review analysing different measures and drivers of the implementation success. A section of the guidelines will refer to mDSS4 – a DSS developed to guide multi-criteria evaluation of different water policies.

Timescales/effort

Workload: 3 PMs

Time schedule: First draft available in September 2006, final version December 2006

Test basin(s)

The enhancement will be discussed in the context of Tisza CS. It will inform the development of DSS in the task 175 (DSS for the transition towards AM) in the same cs.

Detailed breakdown of each part of enhancement

1) Brief review of drivers behind the success and failure of DSS

2) Survey or workshop involving water managers and practitioners regarding the attitude and needs for DSS

3) Development of a policy briefs for the development and application of DSS in water resource management

4) Practical part – demonstration of the guideline on the example of mDSS4

Details of how enhancement should be tested and how success will be assessed

Peer-review by scientists and policy makers; feedback from the case study.

Additional supporting material needs to be prepared

Tutorial – practical examples with tangible and intangible benefits form a practical case

What would be required to apply the tool to more than just one case study basin?

Dissemination material – leaflets

4.2.7 Waterwise

Brief description of enhancement

The 'Waterwise' model (Van Walsum et al., 2002, 2003; Van Walsum, 2005) is an example of a bio-economic mathematical programming model that covers regional hydrologic interactions, effects of land use on water quality, effects on agriculture, effects on nature. The Waterwise tool can be used for land and water use planning that is aimed at complying with the EU Water Framework Directive; the focus is on the nutrient loads coming from agriculture. These loads are influenced by the level of manuring and by the hydrological conditions.

The main deficiencies of the model include lack of technical description and low transferability to different regions. There is also the problem that use is made of proprietary optimization software Xpress (DASH, 2003); for professional use in large river basins the use of such software is inevitable, because 'freeware' codes are not efficient enough to handle the high dimensionality of the computational implementation. But it is realized that the use of such software forms a barrier for users to become acquainted with Waterwise. The enhancement will therefore also address this issue.

Timescales/effort

The enhancement will based on the first working version of the Waterwise model developed for the Kromme Rijn by October 1, 2006. The enhancement can only start afterwards, in the fourth quarter of 2006. The effort of the enhancement will be 1 PM.

Test basin

The Kromme Rijn (Rhine) will be the primary test basin.

Detailed breakdown of each part of enhancement

The transferability to other regions will be increased by providing more flexibility in the input options and model formulation.

The documentation will cover:

- description of model, including the technical formulation in terms of model equations;

- an input/output guide, describing input/out facilities

- a user guide, providing instructions for using a 'hands-on' example application.

The barrier due to the use of proprietary software will be reduced by ensuring that the example data can be run using the 'student edition' of DASH Xpress, which can handle only problems having a limited dimensionality.

Details of how enhancement should be tested and how success will be assessed

The delivered material will be 'tested' by letting a third party use it for implementing a small example in a sub-basin of one of the other case studies, possibly Nile.

Additional supporting material needs to be prepared

In collaboration with 4.3 the material will also be used for setting up a short training course for the use of the model.

What would be required to apply the tool to more than just one case study basin?

For applying the tool to a different basin it should be possible to evaluate the effects of water management measures on the groundwater dynamics and drainage to surface water. Information should be available about the land use and the land management (fertilization and manuring). Waterwise does not do 'simulation' itself: it makes use of results derived from compuational experiments with simulation tools that are supplied externally from the model.

References

DASH. 2003. XPRESS-MP Reference Manual. Dash Associates, Blisworth (UK)

Van Walsum, P.E.V., J.F.M. Helming, E.P.A.G. Schouwenburg, L.C.P.M. Stuyt, C.J.A.M. de Bont, P.H. Vereijken, C. Kwakernaak, P.J.T. van Bakel, L.C. van Staalduinen, P. Groenendijk & K.W. Ypma. 2002. Waterwijs; plannen met water op regionale schaal. Report 433. Alterra, Wageningen (NL).

Van Walsum P.E.V., Helming J.F.M., Groenendijk P., Stuyt L.C.P.M., Schouwenberg E.P.A.G. (2003, submitted). Spatial planning for lowland-stream basins using a bio-economic model. IAHS/IWRM conference in South Africa, 2003.

Van Walsum, P.E.V., J. Runhaar, and J.F.M. Helming. 2005. Spatial planning for adapting to climate change. Water Science and Technology 51(5).

Van Walsum, P.E.V., J.C.J.H. Aerts, J. Krywkow, A. van der Veen, H. der Nederlanden, M. Q. Bos, B.T. Ottow. 2005. Framework for integrated design of water and land management systems; towards robust water-space partnerships as a basis for adaptive water management. Report to the NeWater project, Wageningen.

Van Walsum, P.E.V., J Aerts, B. Ottow. 2006. Integrated Water Resources Management and Spatial Planning in the Rhine basin; Research action plan for Newater pilot study in the Kromme Rijn sub-basin (Work packages 1.4 “Integration of IWRM and spatial planning” and 3.2 “Rhine Case”). Alterra, Wageningen.

5 Annexes

5.1 Annex I: The structure of the GWP toolbox

THE ENABLING ENVIRONMENT	A1	**POLICIES – Setting goals for water use, protection and conservation**
	A1.1	Preparation of a national water resources policy
	A1.2	Policies with relation to water resources
	A2	**LEGISLATIVE FRAMEWORK – water policies translated into laws**
	A2.1	Water rights
	A2.2	Legislation for water quality
	A2.3	Reform of existing legislation
	A3	**FINANCING AND INCENTIVE STRUCTURES – Allocating financial resources to water needs**
	A3.1	Investment Policies.
	A3.2	Public Sector Institutional Reform
	A3.3	Role of the Private Sector.
	A3.4	Cost Recovery and Charging Policies
	A3.5	Investment Appraisal
INSTITUTIONAL ROLES	B1	**CREATING AN ORGANISATIONAL FRAMEWORK – Forms and functions**
	B1.1	Transboundary Organisations for Water Resource Management
	B1.2	National Apex bodies
	B1.3	River basin organisations
	B1.4	Regulatory bodies and enforcement agencies
	B1.5	Service providers and IWRM
	B1.6	Civil society institutions and community based organisations
	B1.7	Local authorities
	B2	**BUILDING INSTITUTIONAL CAPACITY- Developing human resources**
	B2.1	Participatory management and empowerment
	B2.2	IWRM capacity in water professionals
	B2.3	Regulatory capacity
	B2.4	Knowledge sharing

MANAGEMENT INSTRUMENTS	C1	**WATER RESOURCES ASSESSMENT – Understanding resources and needs**
	C1.1	Water resources knowledge base
	C1.2	Water resources assessment
	C1.3	Modelling in IWRM
	C1.4	Developing water management indicators
	C2	**PLANS FOR IWRM – Combining development options, resource use and human interaction**
	C2.1	River basin plans
	C2.2	Risk assessment and management
	C3	**DEMAND MANAGEMENT– Using water more efficiently**
	C3.1	Improved efficiency of see
	C3.2	Recycling and reuse
	C3.3	Improved efficiency of supply
	C4	**SOCIAL CHANGE INSTRUMENTS – Encouraging a water-oriented civil society**
	C4.1	Education curricula on water management
	C4.2	Training of professionals
	C4.3	Training of trainers
	C4.4	Communication With stakeholders
	C4.5	Water campaigns and awareness raising
	C4.6	Broadening participation in water resources management
	C5	**CONFLICT RESOLUTION – Managing disputes, ensuring sharing of water**
	C5.1	Conflict management
	C5.2	Shared vision planning.
	C5.3	Consensus building
	C6	**REGULATORY INSTRUMENTS – Allocation and water use limits**
	C6.1	Regulations for water quality
	C6.2	Regulations for water quantity
	C6.3	Regulations for water services
	C6.4	Land use planning controls and nature protection
	C7	**ECONOMIC INSTRUMENTS – Using value and prices for efficiency and equity**
	C7.1	Pricing of water and water services
	C7.2	Pollution charges
	C7.3	Water markets and tradeable permits
	C7.4	Subsidies and incentives
	C8	**INFORMATION MANAGEMENT, EXCHANGE AND DATA SHARING - Improving knowledge for better water management**
	C8.1	Information management systems
	C8.2	Data sharing – national and international

5.2 Annex II: Summary of gaps

This annex has been produced to stimulate debate within NeWater Work Block 4. The information is derived from Deliverables D.4.1.1 and D4.2.1. The following table has been produced from the perspective of each case study basin and is a summary of the identified needs for tools in each basin. In most cases these are the needs as expressed by representatives of each basin though these needs have been supplemented by further background knowledge where appropriate. The table can to be refined further by extracting further generic data to produce a simpler table that can be used to compare the proposed "fast track" tools for enhancement so as to determine how well each tool satisfies these needs and to identify what needs are not catered for and that will require "new tool" development.

Basin		***Tools for***	***Suggestions***
	1	collecting and exchange of data on basin level	
	2	management of dependable real-time information	
	3	integration of data from different disciplines	
	4	water quantity control	
	5	reservoir management	
	6	flood prevention	
	7	flood prediction	
	8	flood warning	
	9	participation modelling	
Rhine			
	10	estimation of future uncertainties (climate changes and variability; socio-economic development)	
	11	connection hydrological models to policy making models	
	12	connection spatial planning to water management	
	13	integration of water uses with environmental objectives	
	14	actual crisis management	
	15	development and implementation policies of more integrative and sustainable kind	
	16	close cooperation of all basin states	

Basin		*Tools for*	*Suggestions*
	1	water quality control (both groundwater and surface waters)	
	2	droughts prediction	
	3	flood prevention	
	4	flood prediction	
	5	flood warning	
	6	public involvement	
Elbe	7	NGO involvement	
	8	stakeholders involvement	
	9	collecting data from water users and stakeholders	
	10	participation modelling	
	11	estimation of future uncertainties (climate changes and variability; socio-economic development)	
	12	WFD implementation	
	13	close cooperation of all basin states	

Basin		*Tools for*	*Suggestions*
Guadiana	1	complex hydrological modelling	
	2	modelling of groundwater-surface waters interaction	
	3	agro-economic modelling	
	4	water quality control	
	5	economical modelling	
	6	environmental analysis	
	7	irrigation system development	
	8	integrated rural development	
	9	effective groundwater monitoring	
	10	defining groundwater rights	

	11	“water” education	
	12	stakeholders involvement	
	13	development and implementation policies of more integrative and sustainable kind	
	14	trans-boundary water management	
	15	close cooperation of all basin states	

Basin		*Tools for*	*Suggestions*
Tisza	1	collecting and exchange of data on basin level	
	2	management of dependable real-time information	
	3	collecting data from water users and stakeholders	
	4	water quality control	
	5	management of groundwater-surface waters storages	
	6	droughts prediction	
	7	soil degradation and erosion prevention	
	8	flood prevention	
	9	flood prediction	
	10	flood warning	
	11	estimation of future uncertainties (climate changes and variability; socio-economic development)	
	12	stakeholders involvement	
	13	public involvement	
	14	increasing of public awareness	
	15	participation modelling	
	16	more equitable water resources management	
	17	adaptive management	
	18	conflict management	
	19	trans-boundary water management	

	20	close cooperation of all basin states	

Basin		*Tools for*	*Suggestions*
Amu Darya	1	water quality (salinity) modelling	
	2	sediment load modelling on a basin wide scale	
	3	connection between GIS and hydrological models	
	4	cope with high variability in river flow	
	5	cope with extreme events	
	6	runoff prediction	
	7	flow monitoring	
	8	social dimension inclusion into the water management	
	9	public involvement	
	10	stakeholders involvement	
	11	participation modelling	
	12	increasing of public awareness	
	13	“water” education and training	
	14	strengthen water management organizations and institutions	
	15	trans-boundary water management	
	16	development and implementation of IWRM policies	

Basin		*Tools for*	*Suggestions*
Orange	1	collecting data and management of groundwater information	
	2	groundwater modelling	
	3	water quality modelling	
	4	water quality control	
	5	groundwater abstraction control	
	6	extreme events prediction	

	7	water quality monitoring	
	8	groundwater monitoring	
	9	dam operation	
	10	improvement of irrigation efficiency	
	11	public involvement	
	12	participation modelling	
	13	social dimension inclusion into the water management (poverty reduction)	
	14	improved web-based communication	
	15	overall basin management	
	16	development and implementation of IWRM policies	

Basin		***Tools for***	***Suggestions***
Nile	1	collecting and exchange of data on basin level	
	2	simple basin hydrology modelling	
	3	water quality modelling	
	4	water quality control	
	5	water use control	
	6	water productivity optimization	
	7	water quality monitoring	
	8	water use monitoring	
	9	trans-boundary monitoring	
	10	IWRM-linked reservoirs management	
	11	good, fair and equitable water management	
	12	link land management with water management	
	13	estimation of future uncertainties (climate changes and variability; socio-economic development)	

	14	poverty and gender issues integration into water management	
	15	stakeholders involvement	
	16	increasing of public awareness	
	17	participation modelling	
	18	“water” education and training	
	19	promoting of water conservation at the user level	
	20	conflict resolution	
	21	trans-boundary water management	
	22	close cooperation of all basin states	
	23	strengthen water management organizations and institutions	
	24	development and implementation of IWRM policies	

5.3 Annex III: More detailed description of the some tools

5.3.1 Upgrading the UN-GWP Handbook to a NAM (NeWater Adaptive Management) ‘Starter Kit’

By Carol Webb and Paul Jeffrey, Cranfield University, UK

The current UN-GWP handbook, “Catalyzing Change: A handbook for developing integrated water resources management (IWRM) and water efficiency strategies”, is a text based tool of 51 pages, delivering content on: the IWRM concept (basic principles, advantages, and implication for water governance); guidance on choosing an entry point into the strategy development process and on defining core issues and reforms the strategy needs to address; issues of managing a strategy development process; and, suggestions for ensuring effective implementation and change. While there are a few tables and figures with bullet point information, and the style of writing is very engaging, the delivery of the material overall is very dry. The current tool makes use of only one of predominant 6 learning styles and preferences (visual text). Therefore the proposed enhancement is to integrate other learning styles and preferences in a new interpretation and delivery of the tool.

Boyle (Boyle, 2005) draws on the learning styles theory literature and describes the perceptual, physiological, sociological, psychological, environmental, and emotional elements and preferences of learning that differ from person to person. Perceptual elements, he explains, affect the way we learn and retain information, and this category includes six main learning styles: auditory; visual picture; visual text; tactile; kinaesthetic; and, verbal (internal) kinaesthetic. Boyle argues that individuals have personal preferences or strengths in at least one of these styles of learning, but that this differs from person to person. These styles and their implications for learning are represented in the figure below.

In addition, while the current UN Handbook provides concise and valuable information for managers, it does not articulate this in the context of their own experiential learning process. To enhance the current tool to improve its delivery in this area, it will be necessary to look to Kolb’s learning cycle. Describing humans as the learning species, Kolb (1984) grounded the need to learn in survival dependent on the ability to adapt, both in the reactive sense of fitting into the physical and social world, and in the proactive sense of creating and shaping those worlds. Kolb therefore proposed a holistic integrative perspective on learning combining experience, perception, cognition, and behaviour. In elaboration of how this continual process of learning takes place, Kolb (Kolb,1979) presented the learning cycle (see adapted representation of this, in the figure below), which is based on the notion that learning is a cyclical process which needs to contain elements of each quadrant of the cycle before learning is possible. This cycle is described in the following way:

"Immediate concrete experience is the basis for observation and reflection. These observations are assimilated into a 'theory' from which new implications for action can be deduced. These implications, or hypotheses, then serve as guides in acting to create new experiences" (Kolb, 1973:2).

Also, the UN Handbook lacks a context of delivery in terms of technological means and social context. The state of the art in learning tools and methods puts the spotlight on these two predominant areas: technological means; and, social contexts of learning. Over and above these two areas are the ways in which learning is enabled by either technological means or within the social context.

Through advancements in technologies offered by ICT applications and the Internet, learning has been enhanced through increased multimedia support (Kearney, 2004) and the general development of 'elearning' in all its forms (Buckberry, 2005; Burns, 2005; Duggleby, Jennings, Pickering, Schmoller, Bola, Stone, and Willis, 2004; O'Leary, 2005; Newcombe, Sluzenski, and Huttenlocher, 2005; Sambrook, 2003; Lytras, Naeve, and Pouloudi, 2005). The recent phenomena of 'blogging' – the upkeep of a web log, usually on a particular theme or in relation to the thoughts or activities of a specific individual or group – has also opened up new avenues in which learning opportunities can be explored (Flatley, 2005; Williams and Jacobs, 2004). More generally it has been acknowledged that the internet provides specific opportunities for learning to take place in the form of online discussion (Johnson, Howell, and Code, 2005), online learning with others (Russon and Benson, 2005), through virtual learning groups (McFadzean and McKenzie, 2001), collaborative virtual learning (Steif and Dollar, 2004), in virtual communities of practice (Allen et al., 2004), or co-reflection in online learning environments (Yukawa, 2003). Such opportunities have and are being leveraged to maximise learning, and recent developments in this field include the use of virtual collaborative learning with a tutor-agent (Marin, Hunger, Werner, Meila, and Schuetz, 2004), simulation gaming and digital simulation games (Squire, Barnett, Grant, and Higginbotham, 2004; Bailey, 1990), the creation of virtual business environments (Wiersma, 2004) and the facilitation of learning emotional intelligence with synthetic characters (Paiva, Dias, Sobral, Aylett, Woods, Hall, and Zoll, 2005). Therefore, technology has opened up a vast range of possibilities in which online professional development can take place (Vraisidas and Zembylas, 2004). This focus on technology, however, has not detracted from work going on to facilitate learning in diverse social contexts –that do not necessarily dictate a technological interface.

The recent focus on learning in the social context is referred to in terms of learning through social networks and groups (Liebeskind, Oliver, Zucker, and Brewer, 1996; Chiffoleau, 2005; Gear, Vince, Read, and Minkes, 2003; Matthews and Shulman, 1999; Reynolds, 1994), in specific learning communities (Meyer, 2005b; Smith and Standish, 2000), and, through strategic alliances in social exchange (Muthusamy and White, 2005). Learning in these contexts can be mitigated through specially designed collaborative learning environments (Blouin, 2005; De Corte, Verschaffel, and Masui, 2004), or, more informally, for example, in a social context characterised by change (Aoki, Wakano, and Feldman, 2005), or through a lifelong learning network (Blackie, 2005; Watson, 2005). This can take the form of localised learning in social contexts (Pilotti, 1999), in communities of competence (Smith, 2005), in informal networks (Van Aken and Weggeman, 2000), and, at the regional level (Weil, 2004), or simply as collective learning in small businesses (Mitra, 2000). The state of the art tools and methods which draw together the facilitation of learning either via technological means or in a social context can be adapted to fit either mode. A few of these are outlined below:

A range of learning orientated tools, methods and material already exists in the scope of management development (Burgoyne and Stuart, 1991), which can, for instance, be deployed in the context of specific organisational learning initiatives (Yeo, 2005) or in order to develop bespoke management tools and practices (Chen, 2005a). State of the art tools and methods are grounded in either of, or a combination of kinesthetic, tactile, visual text, verbal kinesthetic, and visual picture styles of learning, as defined by Boyle (2005) above. Some tools in particular have a stronger leaning also towards methods grounded in Kolb's experiential learning, articulated through his learning cycle (1984). Fitting into this latter category is the specific deployment of experiential learning techniques (White, 1992), as implemented through, for example, facilitated interventions (Heron, 1989), in-company vocational learning (Olsen, 2004), competency-based education (Macfarlane, 1994), or in attempts to motivate learning through usefulness, as in the case of interest-driven frameworks (Edelson and Joseph, 2004) – see also Boyle's (2005) psychological factors relating to motivation in this particular context. Under the heading of experience-based kinesthetic and tactile approaches are real-life exercises and simulations (Ball, 1995), specific management development games and simulations (Wells, 1990), learning through engaging (Comerford, 2005), or through play (Thompson, 2005). Bringing together the approach of experiential learning with tactile and visual text learning styles is the use of learning diaries (Peck, 1996) and learning logs (Barclay, 1996b; Barclay, 1996a). Verbally kinesthetic methods, which focus on learning through discussion with others, include the facilitation of dialogue in specially intended environments (Tan and Brown, 2005), focussing on the conversation and interaction with others in groupbased contexts (Stacey, 2003a; Sense, 2005), and interactive issue-based learning (Ocon, 2004). Methods leveraging visual picture learning styles include the use of scenarios (Bood and Postma, 1997) and metaphor (Burgi and Roos, 2003). It is clear that the current UN Handbook would benefit through enhancement based on any of these ideas.

Perhaps deserving of a bit more attention here is the use of metaphors – drawing on the context of their use in adaptive management in general and complexity science in particular. Many analogies and metaphors are used to elaborate ideas from complexity science, as with examples from the natural world relating to ants, termites, birds, and bees. The term complex adaptive system (CAS) is used as a metaphor to explain a network of interrelating agents whose interactions can produce complex evolution. Metaphors used to explain different parts of this idea include 'the Cambrian explosion' (a metaphor for complex evolution), and an 'ecosystem' (a metaphor for a network where complex interaction takes place) (Lewin, 1999). In this sense metaphors are 'a way of thinking and seeing things' in the natural world, and transferring these thoughts elsewhere (Morgan 1986:12). Metaphors 'bring new perspectives into existence' – and in this instance a new perspective is provided for organisations (Grant & Oswick 1996:2). This is especially interesting where members of an organisation are seeking to adapt with each other and with other external stakeholder and organisational players. Where stakeholders can bring new perspectives into existence together it can be very rewarding in terms of 'co-evolution'.

Metaphors have been used to talk about organisations since at least 1873 (Grant and Oswick, 1996). E.g. the organisation has been 'seen' at different periods as either a machine, organism, culture or collage (cf. Hatch 1997). The implications of the application of these metaphors have been far reaching and have driven managerial concepts accordingly (c.f. F W Taylor, 1911, Scientific Management). The organisation as a 'collage' metaphor is particularly helpful now when seeking to understand the place of complexity science principles in a practical context. Key thinkers of the 1990s onwards have contributed to what

Hatch (1997:5) defined as a 'postmodern' inspiration to organization theory. The metaphor of the postmodern perspective of organization theory is that of a collage, where the image of the organisation is seen as a collage made from bits of knowledge and understanding brought together to form a new perspective that has reference to the past. The image of the manager is that of a theorist, where the theorist is an artist (Hatch 1997:52). To this extent the theorist/artist manager has the remit to use metaphor at another level – to create a 'strategic pastiche'. The source of the manager's materials for her pastiche is, in this case, the metaphors and analogies derived from complexity science.

The application of metaphors is therefore multiplicitous and they can be turned into tools to adaptively respond to problems. However, metaphors do have limitations which need to be observed. "Metaphorical extensions can serve as useful antidotes to…linear dynamics. But the metaphorical use of chaos theory can be misused if terminology is construed too broadly, or if the criteria for chaos are interpreted too loosely" (Kellert, 1995). Metaphors can be constraining, misleading, be pushed too far, be ideologically distorting, and therefore can create a false consciousness, where inequalities of power become invisible (Grant & Oswick 1996). In short, however, metaphors, whether based directly or indirectly on complexity studies, afford an opportunity to provide creative solutions to complex problems and make sense of experiences in general.

The language and metaphor of complexity science principles has been recognised for its potential in enabling people to re-visualise their world (McMillan, 2004), by means of developing new ways of speaking and thinking about it, and in turn enabling new thinking to lead to new behaviour. McMillan draws on the work of Morgan (Morgan, 1986) in this context and suggests that of his eight metaphors describing organisations, the metaphor of the organisation as an organism, with links to biology and biological thinking, appear most relevant to the pursuit of linking metaphors and analogies from complexity science to organisations and work, and the experience of the individual and groups in that context. This correlates strongly, for example, with the description of bee hives, ant hills, termite mounds and bird formations as used to explain the theory of complex adaptive systems. These metaphors and analogies from the natural sciences then lend themselves to sense-making and learning about experiences of work and working in organisations. In this way, complexity science is understood to provide metaphors and analogies that give meaning to observed, experienced, and simulated reality (Fuller, 1999; Fuller, 2000; Lissack, 1999; Stacey, 2003a; Stacey, 2001; Price, 1999). It will be therefore worthwhile to explore how complexity science principles can lend themselves as metaphorical tools to the context of adaptive management for IWRM, and how they can be seen to inform and add value to the UN workbook content.

Finally, as previously stated in earlier deliverables, IWRM is not informed by AM and this needs addressing in this tool.

5.3.2 Adaptive Monitoring Design Support System (AMDSS)

by Raffaele Giordano, Michele Vurro (CNR-IRSA)

Adaptive management is essentially about learning, adapting to changing conditions and anticipating on possible changes. An adaptive monitoring system should therefore be inherently flexible and able to adapt to changes. Next to that, water monitoring should be an integral part of the water management process as well as the water governance process. The information cycle depicts monitoring as following from water management and feeding back to water management.

The information cycle (Figure 1) is a framework to describe the adaptive approach to monitoring design. It describes how monitoring in the broad sense of collecting information to support integrated water management should be developed and implemented.

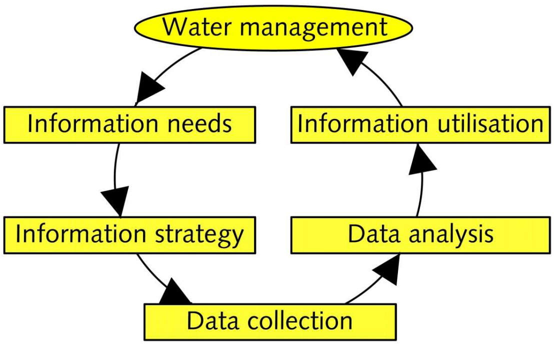


Figure 1: The information cycle

In the information cycle, information users in close dialogue with information producers decide upon the characteristics of the information that is needed: the information needs.

Specification of information needs is a means to make a translation from a policy problem into an information management issue in the information cycle; the water policy and management objectives are translated into information expectations that in turn forms the basis for an information production network. Information needs are specified in close interaction between information users and information producers.

Among the several methods that have been developed to support the information needs definition, we focus on the information needs hierarchy (Timmerman and Mulder, 1999). This method provides a five-step plan that enables managing the information needs definition process.

The process starts with the exploration phase, setting the scope and boundaries of the study. After exploring the scope, the study is initiated by developing a conceptual model of the system, based on the integrating decision-model, and identifying gaps and controversies in the information model. The available (policy) plans are considered through the conceptual model and the derived aspects will lead to the fundamental objectives. The information users as stakeholders play an important role in this step. A first structured breakdown in the form of an information needs hierarchy is discussed in this phase with the identified stakeholders leading to a broad understanding of the process as well as of the problem. After the initiation, the information needs have to be further elaborated and compared to the present information situation. The information model is further explored and elaborated, and the structured breakdown is detailed into a fully-fledged working scheme in an iterative way in this step. The existing, real world situation is included in the analysis and the results are discussed with the identified stakeholders in the conclusion step. A comprehensive overview of the results is produced after this in the completion step making the results transparent for those people that were not involved in the process and transferable to the actors that take care of the implementation of the results (Timmerman and Mulder 1999).

Monitoring has to be considered as an ongoing activity. During monitoring, targets may be reached or policies may change, implying that the monitoring strategies may be adapted. Moreover, feedbacks are acquired about the performances of the monitoring program with respect to design, technical issues and evaluation. The information users' perspectives may change, influenced by the evolving knowledge of the participants of the issues at stake through the learning process, resulting in new information needs. Therefore, information needs are not static, since they change during the decision process, i.e. the information required depends upon the stage in the policy cycle. Each information need poses specific requirements to the monitoring system in terms of performances, methodologies and evaluation and presentation of data.

The information needs definition has to be considered as an iterative process. The adaptive approach to monitoring design iteratively refines the monitoring design as a result of experience in implementing the monitoring program, assessing its results and interacting with the users. Thus, the importance of learning in an adaptive perspective can be extended also to the information production process.

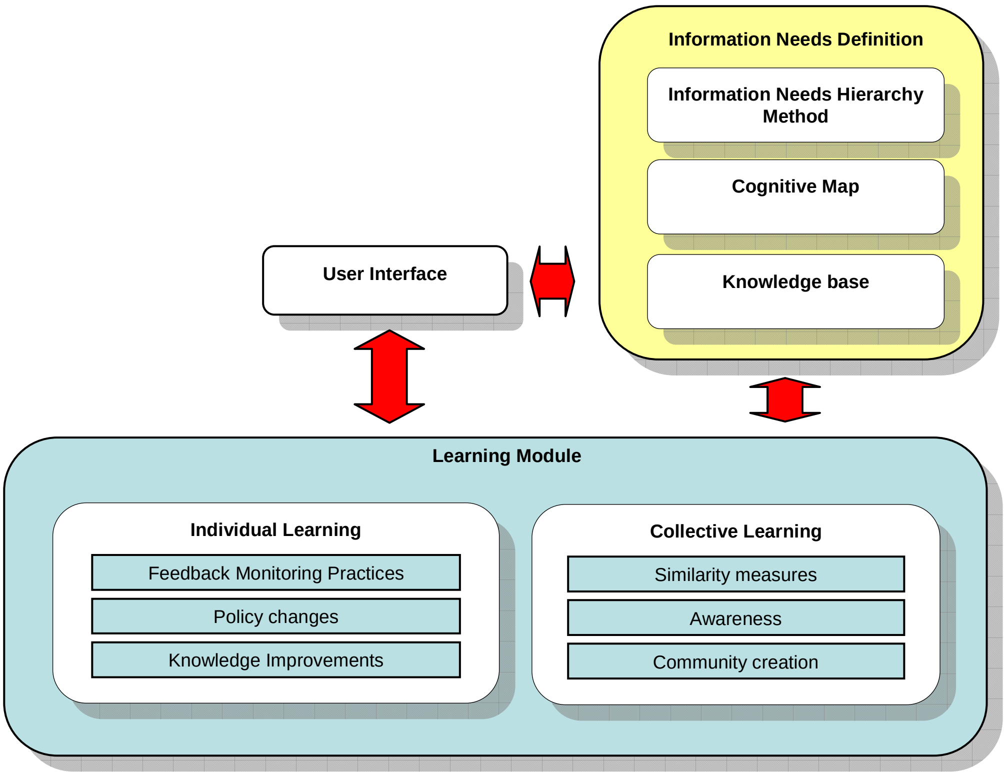
The difference between the traditional approach to monitoring design and an adaptive approach is that in the adaptive approach the barriers to monitoring design are overcome by adaptively implementing monitoring rather than waiting for new information or designing a system that does not anticipate new information.

Thus, the aim of the IRSA contribution to the WP 4.2 concerns the definition of a System able to support the Adaptive Monitoring Design (AMDSS). This system will enhance the potentialities of the information needs hierarchy, taking into account the dynamics of the processes influencing the information needs.

The AMDSS will lead the users in the process of information needs definition, according to the Information Needs Hierarchy method. It will support the adaptive design of the monitoring information system, allowing the users in changing the information needs and in assessing the implemented monitoring strategies. The AMDSS will support learning processes in the information production.

Starting from the idea that learning process in organization is strongly influenced by members interaction and information sharing, a virtual space in which water manager can share experiences in adaptive water management will be provided. To support the interaction in this virtual space, an intelligent agent able to define similarities among the users' interests will be defined. According to a similarity measure, the agent should facilitate the contact between users having similar interests.

The architecture of the AMDSS can be schematised as following:



The main enhancement to the Information Hierarchy Method is the learning module. This module, based on methodologies to support both the individual and collective learning, will lead the users in the adaptive design of monitoring system.

The modules are described in detail in the following section.

As reported in the previous section, the AMDSS will support the user in the adaptive design of monitoring information system. Thus, the AMDSS will firstly support the definition of the information needs according to the Information Needs Hierarchy method and, secondly, to iteratively refine them in a learning perspective.

1. Information Needs Definition Module.

This module will be based on the methods proposed by Timmerman and Mulder, and will support the user in defining the information needs.

The module will be designed to guide participants through a participatory approach that includes different points of view to look outside these known issues and leads to smart choices and more creative solutions, in particular where no norms or standards exist.

One important aspect of organising a problem is to structure the problem by making a cognitive map or mental model. Such a model describes an overall view on the problem that must be followed by focussing and reducing the scope until a comprehensive understanding of the problem is obtained. The user will be asked to reflect on the fundamental objectives that are relevant for a water body and then think along three basic lines formed by the core elements in water management

The first line is to make criteria for objectives operational. Through this line it becomes clear what is essential for reaching the objectives. The second line is to make an inventory of problems and opportunities that influence reaching the objectives. This defines how the environment (for instance the biophysical conditions) limits or enhances reaching the objectives. The third line is to identify measures directly related to problems or more generally related to the fundamental objectives. This gives insight into what is already done and what can be done in future.

The first outcome of this module is a cognitive map that can be used to define the user's interests in environmental monitoring. This information will be used as input for the knowledge base, containing information and data needs for adaptive water management according to the data from NeWater case study regions, literature surveys, and specific expert consultations (Task 1.6.2). Using this knowledge, the module will support the user in defining the information needs.

2. Learning module

The learning module represents the enhancement proposed by IRSA for the WP 4.2. This module aims to support the adaptive monitoring design, supporting the learning process.

The learning module will be composed by two main sub-modules, the individual learning and the collective learning. The aim of the former is to lead the user in iteratively revising the information needs. A methodology will be proposed to support the individual learning process.

According to the scientific literature, the innovation adoption process is composed of the following steps:

- awareness: the user knows that something new exists;
- interest: the user gains information and develops his curiosity;
- trial: the user tests the new idea;

- adoption: the user introduces the innovation into his work resources.

Consequently, the proposed methodology has to be able to facilitate stakeholders' learning process by supporting the following activities:
- information acquisition about innovation opportunities;
- innovation evaluation;
- testing of innovation change in the context;
- experience evaluation.

The methodologies proposed in the scientific literature will be adapted to the information needs definition process. E.g., the AMDSS will support the awareness about the necessity to revise the information needs.

The collective learning module is based on the *communityware* research field. Communityware can be defined as an electronic medium that facilitates the contact with unknown collaborators who have similar interests and preferences.

Community-ware essentially includes three different functions to encourage interaction:
- Knowing each other;
- Sharing preferences and knowledge;
- Generating consensus.

The basic idea is to create groups of people who share the same interests by analyzing each individual's interests. The resulting clusters can be used for the cooperative solution of problems. To create these clusters, a fuzzy clustering methodology may be used.

The relevance of supporting collective learning processes derives from the consideration that communities perform better when all members adopt certain behaviours, such as sharing their knowledge or making effective use of the knowledge produced by others. The adoption of communityware methodology will provide all members of the community with the ability to efficiently and effectively identify others within the community who share common and complementary interests and how to directly or indirectly connect to them and thus support collective learning processes.

5.4 Annex IV: Contributors to the report

This report is the result of discussions between all partners in the NeWater WP2. It has been edited by Jaroslav Mysiak. The different chapters were written by the following persons:

Chapter 1: *Jaroslav Mysiak, FEEM*

Chapter 2: *John Bromley, CEH, Tom Brabben, HRW, Jaroslav Mysiak, FEEM*

Chapter 3: *Heidi Barlebo, GEUS, Tom Brabben, HRW, Raffaele Giordano, IRSA, Joern Moeltgen, GEUS, Jaroslav Mysiak, FEEM, Peter van der Keur, GEUS,*

Chapter 4.1: *Jaroslav Mysiak, FEEM*

Chapter 4.2.1: *Heidi Barlebo and Peter van der Keur, GEUS,*

Chapter 4.2.2: *Carol Webb and Paul Jeffrey, CRAN*

Chapter 4.2.3: *Erik Mostert and M.I. Poolman, TU Delphy*

Chapter 4.2.4: *Raziyeh Farmani and Dragan Cavic, UNIEXE*

Chapter 4.2.5: *Raffaele Giordano and Michelle Vurro, IRSA*

Chapter 4.2.6: *Jaroslav Mysiak and Carlo Giupponi, FEEM*

Chapter 4.2.7: *Paul van Walsum, Alterra*