NeWater

New Approaches to Adaptive Water Management under Uncertainty

Summary Activity Report

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I Executive Summary of the NeWater project

The central issue of the NeWater project was the requirement for a transition from currently prevailing regimes of river basin water management to more adaptive regimes in the future. This transition calls for a highly integrated water resources management concept. NeWater identified the following key elements of the water management system: governance, sectoral integration, scales of analysis, information management, infrastructure, finance, and risk mitigation. Research focused on processes of transition of these elements to more adaptive processes of Integrated Water Resources Management (IWRM). The development of concepts and tools that guide an integrated analysis and support a stepwise process of change in water management was the cornerstone of research activities in the NeWater project.

The core aim of NeWater was to understand and facilitate change to adaptive strategies for integrated water resources management. These strategies were tailored to the institutional, cultural, environmental, and technological set-tings of river basins. They took into account the socio-ecological vulnerability and the adaptive capacity of the individual basins. One objective of NeWater was thus the development of the integrated Management and Transition Framework (MTF) in order to support analysis of the role of key elements in the transition process. A guiding principle was the co-development and co-application of knowledge and tools supporting adaptive water management in seven case study basins.

NeWater also shared experience and innovations through dialogues and publications to advance European research in water management and to support the implementation of the Water Framework Directive and EU Water Initiative.

Seven river basins (Amudarya, Elbe, Guadiana, Nile, Orange, Rhine and Tisza) were selected as case study areas to establish the link between practical activities and advances in thematic research and tool development. The goals and needs of stakeholders were carefully considered in collaboration with scientific partners and other experts.

NeWater has produced more than 200 deliverables. All public results are available on the website. A synthesis of the deliverables guided to the following 12 products:

1. The prototype of the Management and Transition Framework including databases on management processes, learning processes and a general system description for several basins.
2. The Uncertainty Guidelines providing insights on how different types of uncertainty can be approached in adaptive management processes.
3. A synthesis of those NeWater results addressing the “burning policy issues” related to uncertainty, stakeholder participation and global (climate) change.
4. A climate and water adaptation book providing insights into various adaptation strategies for climate change.
5. An evaluation of water resources scenarios for the case study regions taking up the most recent results of climate development simulations.
6. A comparison of adaptation strategies across regions addressing the differences in awareness of and strategies for climate change.
7. The description of a process for analysing dynamic vulnerability and adaptive capacity.

8. A special issue on participation presenting the diversity of participatory approaches for research and management. For more details see Ecology and Society Online Journal (http://www.ecologyandsociety.org/).
9. The NeWater Guidebook on Adaptive Water Management explaining benefits and outcomes of, as well as lessons learned from making the transition to adaptive water management.
10. A special section on Adaptive Water Management was integrated into the WISE-RTD portal (http://www.wise-rtd.info/) providing additional access to all the main NeWater outcomes.
11. A CD with training material to build capacity among those who “train” the water managers.
12. The Online teaching curriculum providing academic instructors with teaching materials on the theme of adaptive river basin management (http://www.newatereducation.nl/).

II NeWater Consortium

The NeWater project unites over 40 partner organisations in the EU & abroad. Full partners include (terms in brackets refer to the partner's abbreviations):

- Institute of Environmental Systems Research, University of Osnabrück (USF)
- Alterra, Wageningen University and Research Centre (ALTERRA)
- Centre for Ecology and Hydrology Wallingford (CEH)
- Cemagref
- Geological Survey of Denmark and Greenland (GEUS)
- HR Wallingford Ltd. (HRW)
- International Institute for Applied Systems Analysis (IIASA)
- Stockholm Environment Institute, Oxford Centre (SEI-Ox)
- Tashkent Institute of Irrigation and Melioration (AMII/TIIM)
- Center for Environmental Systems Research, University of Kassel (CESR)
- Research Group Work, Organizational and Personnel Psychology, Catholic University Leuven (WOPP)
- Cranfield University (CRAN)
- Ecologic Institute (ECO)
- Fondazione Eni Enrico Mattei (FEEM)
- Helmholtz Centre for Environmental Research (UFZ)
- International Centre for Integrated Assessment and Sustainable Development, Maastricht University (ICIS)
- Institute of Hydrodynamics, Academy of Sciences of the Czech Republic (IHAS)
- Institute of Natural Resources (INR)
- Water Research Institute, National Research Council (IRSA)
- Instituto de Soldadura e Qualidade (ISQ)
- International Union for Conservation of Nature (IUCN; Int. NGO)
- Manchester Metropolitan University (MMU)
- Max Planck Institute for Meteorology (MPI)
- National Scientific Centre for Medical and Biotechnical Research (NSCMBR)
- Potsdam Institute for Climate Impact Research (PIK)
- RBA, Delft University of Technology (RBA)
- Rijkswaterstaat, Centre for Water Management (RWS-CWM)
- Seecon Deutschland GmbH (Seecon)
- T. G. Masaryk Water Research Institute (TGM-WRI)
- Complutense University of Madrid (UCM)
- Umeå University (UMU)
- University of Exeter (UNEXE)
- Technical University of Madrid (UPM)
- University of Twente (UTW)
- Faculty of Earth and Life Sciences, VU Univ. Amsterdam (VU-IVM)
- Wageningen University (WU)
- Center for Development Research, University of Bonn (ZEF)
- University of Oxford (OUCE)
- Geological Survey of Spain (IGME) (*Partner without EU-Funding)*

III Overview of Work Packages

WP No.	Title of WP
1	**Transition to adaptive management in river basins**
1.1/1.7	Adaptive management regimes and methods for the transition to adaptive management
1.2	Governance, institutions and participation
1.3	Transboundary regimes
1.4	Integration of IWRM & spatial planning
1.5	New methods of managing buffering capacity
1.6	Transition to advanced monitoring systems for adaptive management
2	**Vulnerability and adaptive management in the river basins**
2.1	Vulnerability & exposure to shocks and stresses
2.2	Understanding the consequences of climatic hazards and climate change in IWRM
2.3	Resolving conflicts between water quantity, quality and ecosystems
2.4	Social dimension of IWRM: poverty, health, gender
2.5	Resilience & adaptive capacity of complex coupled systems
2.6	Scenarios and future trends in driving forces for IWRM
3	**Case studies in river basins**
3.1	Coordination and stakeholder support
3.2	Rhine basin
3.3	Elbe basin
3.4	Guadiana basin
3.5	Tisza basin
3.6	Amudarya basin
3.7	Nile basin
3.8	Orange basin
4	**Guidance and tools for practitioners**
4.1	Compendium and best practices from case studies
4.2	Tool development
4.3	Guidance and training
5	**International expert and thematic platforms**
5.1	European IWRM expert platform
5.2	Global IWRM research to application platform
6	**Management and project internal coordination platform**
6.1	Project management platform coordination and management
6.2	Synthesis and Scientific Dissemination
6.3	Training and Education

IV Summary of Work Blocks

IV.1 WORK BLOCK 1 (WB 1): Transition to adaptive management in river basins

Leader(s): Claudia Pahl-Wostl, USF, and Jan Sendzimir, IIASA

IV.1.1 Objectives

WB1 focused on the **transition** to **adaptive management** (AM). The work block played a key role in the project. A conceptual framework for transition processes and the adaptive management of river basins was developed and applied. The framework integrates the natural sciences, engineering and social science concepts and methodologies, and bridges the science-policy interface by actively engaging stakeholders in the research process. The role of key factors for the transition to adaptive management was analysed, including governance, participation, information management and spatial planning. A range of tools tailored to the institutional, cultural, environmental and technological settings of river basins was developed to assess and manage transition processes. Activities in WB1 were characterized by conceptual and methodological developments and intensive empirical work within the cases. The work carried out in WB1 attracted a great deal of attention in scientific, policy and practitioners' communities.

IV.1.2 Progress toward meeting objectives

Overall, the progress towards meeting the set objectives was satisfactory, and even exceeded expectations regarding the development of a general conceptual and methodological framework. Due to time constraints imposed by the duration of the project, the framework development and empirical analyses were performed in parallel rather than consecutively, which led to difficulties in creating comparable databases for the different basins.

The increase in shared appreciation of the concept of adaptive management and the required paradigm shift was astounding, not only in the project consortium but also in the stakeholder groups of the different basins. However, several work packages (WPs) suffered delays in their work at the case study level due to the complexity of stakeholder interactions. Nevertheless, progress was made through dialogue with stakeholders in all of the WPs. Such debate led to the raising of important and sometimes even controversial issues, e.g. regarding transboundary water management, uncertainty and risk management or the need to integrate spatial planning. The implementation of transition processes towards more adaptive and integrated management regimes was met with limitations since stakeholders are reluctant to engage in processes of change without guaranteed continued support after the completion of the project.

IV.1.3 Major achievements

The NeWater Management and Transition Framework (MTF) made major progress in terms of improving the **conceptual and methodological foundations** and the implementation of comparative analyses and case study integration.

A major break-through was the development of a conceptual and methodological management and transition framework (MTF) coordinated by WP 1.1/1.7. The MTF

- is a flexible framework to analyse complex water management and multi-level governance regimes and transition processes

- does not promote panaceas but a diagnostic approach embedding problems into a system's context
- is applicable in and supports the analysis of different environmental and governance contexts
- provides a basis for comparative analysis (standardised language)
- supports more rigorous analysis by helping to set priorities, structuring problems and processes to deal more effectively with them, helping to collect more standardised data and facilitating the development of simulation models and their comparison to empirical data.

Comparative analyses of factors that determine adaptive capacity and the capacity to learn were conducted in a wide range of river basins. They partly confirmed the hypotheses on the nature of structural characteristics of integrated and adaptive management regimes.

Progress was made in analysing and classifying major sources of uncertainty in water management and their implications for management. A relational concept for uncertainty was developed which analyses uncertainty as a property of the relationship between actors and their environment. Empirical studies confirmed the importance of framing and undertaking changes in dominant perspectives for dealing with uncertainty and surprise.

Governance plays a key role in adaptive management. WP 1.2 developed an operational approach to assess the degree of adaptiveness of water governance regimes. This approach proved to be very useful for the further comparative analysis of all NeWater basins. The work on trans-boundary issues coordinated by WP 1.3 made a significant contribution to the conceptualisation of institutional issues in transboundary contexts with a view to adaptive water management (AWM). The work performed furthermore contributed to a better understanding and acknowledgement of the relevance of information management in transboundary basins, as well as the role of donors in facilitating adaptive water management practices. By covering river basins in different regional contexts, it was possible to highlight not only the differences but also the similarities between the institutional structures and processes in the river basins. The role of information management was addressed in depth by WP 1.6, which delivered a concept and methodology for designing an Adaptive Monitoring Information System (AMIS). The work performed in WP 1.6, in which an expanded concept of buffering capacity was linked to adaptive management that increased buffering capacity, widens the scope of management options and paves the way towards the transition to adaptive water management

Progress was also achieved in the (further) development of a variety of **simulation models tools** to support the analysis and implementation of adaptive management and transitions processes. Tools developed by WP 1.7 included role playing games, innovative decision support approaches, agro-economic assessment frameworks and agent-based models to understand the complex dynamics of learning and change. WP 1.4 developed and refined the Waterwise tool to support the integration of spatial planning, or land use changes, to be more precise, and IWRM in the framework of adaptive management. Waterwise was made operational in the Nile and the Rhine in close collaboration with stakeholders. To increase the buffering capacity of basins, WP 1.5 developed a comprehensive set of simulation tools to manage the water stored in artificial reservoirs. The Adaptive Monitoring Information System (WP 1.6) has a strong emphasis on the integration of different sources of information. The main characteristic of the system is its capability to integrate different sources of information in order to close gaps in the data. In particular, the system is able to integrate traditional monitoring information with models results and locally-based information derived from local stakeholder knowledge. Concerning the latter point, the system is able to process qualitative information and to make it usable in the support of decision-making processes.

Innovative methods were made available for water management practitioners by translating scientific insights into **practical guidance** on different topics. Guidelines were developed on dealing with different kinds of uncertainty and on applying the concept of buffering capacity to practical situations.

A web-based portal for practitioners was developed as an interface between the perspectives and needs of water management practitioners and insights from scientific analyses.

Members of WB1 were highly productive regarding **scientific publications** and presentations at **international conferences**. An international workshop was organised on 'Water Transitions, a Policy Science Perspective', which led to the publication of a book on the topic. A large number of papers have been published in scientific journals, including a special issue in Ecology and Society on "Adaptive Water Management" and a special issue in Environmental Science and Policy on "Water Governance and Management in Times of Change". The work on the financial sector in developing a response to flooding in the context of climate change was published as an article in Science. The work from WB1 has a leadership role in water governance and adaptive and integrated water management with a focus on the human dimension.

IV.1.4 Main messages

Comparative analyses of the different case studies conducted by WP 1.1/1.7 showed that implementing adaptive and integrated water management requires

- a balance between decentralisation and central coordination to avoid both fragmentation and rigid central control
- an explicit integration of learning cycles into policy and management processes
- no panaceas but a "diagnostic approach"
- a paradigm shift in science, policy and management in our understanding of what "management" means
- an integrated system design to build and sustain enabling structural conditions.

Climate change has raised awareness of the vulnerability of current water management and governance regimes and has promoted a surge in interest in adaptive and flexible approaches. However, the need for change is mainly addressed at the level of political and societal discourse. However, such change has not yet been implemented at the operational level.

Uncertainties are still perceived as major obstacles. However, rather than devoting efforts to futile attempts to reduce uncertainties in order to retain established practices, irreducible uncertainties need to be accepted and efforts channelled towards developing robust strategies that perform well under uncertainties. Regarding risk management, insurance could play a greater role in flooding policies across Europe (WP 1.2).

The work from all of the WPs showed clearly that although water transitions cannot be managed or controlled, they can be influenced by preparing solutions beforehand and by recognising and exploiting windows of opportunity.

WP 1.3 was able to show that transboundary cooperation is of crucial importance in facilitating adaptive water management at the river basin level. Information management plays a crucial role as a door-opener for collaboration. Donor organisations need to focus their efforts on this aspect.

Regarding the use of more elaborate tools to support negotiations on options, for the Waterwise model WP 1.4 observed that such tools need to be implemented early on in the policy process before major problems can emerge and choices have been made. The dilemma is that under these circumstances stakeholders will be less interested in entering a new negotiation process again.

WP1.5 concluded that making the buffering capacity concept operational requires indicators and simple and transparent models. In the context of buffering capacity assessment, the most important selection criterion is transparency for stakeholders: models introduce an additional level of complexity

in the whole process of buffering capacity assessment. This complexity can induce rejection by stakeholders if they feel detached from the model building process.

In order to support AWM, a monitoring system should address important issues concerning complex system dynamics (WP 1.6). Here, the scale issue is of outmost importance. AWM requires the procurement of reliable information on different parts of the spatial and temporal continua. Taking these issues into consideration, AWM often results in a demand to monitor a broad set of variables, with prohibitive costs if monitoring is performed using only traditional scientific methods of measurement. To enhance the economic sustainability of the system, allowing long time series of data to be collected, as required by AM, the design of a monitoring program should include and integrate various kinds of knowledge.

IV.1.5 Outlook

NeWater developed a management and transition framework (MTF) and laid the foundations for a global database of water management and governance regimes. Conceptual and methodological improvements and further in-depth analyses are required to obtain better empirically grounded statements. In order to cover a broader spectrum of river basins and to derive universally applicable tools to facilitate transitions to adaptive water management, additional cases should be investigated. The way has been paved by applying the MTF to additional basins in China (Yangtse, Yellow River) and Australia (Murray Darling) and to further transboundary basins, the Mekong.

Further funding to continue the stakeholder processes in the different basins is urgently required to build on the social capital and trust developed and to support vital processes of change.

Climate change has found its way to the top of the policy and practitioners' agenda over the past two years. More work has to be performed to analyse the needs for change in European policies and its implementation to deal with increasing uncertainties due to climate change.

The project PSI-Connect will continue the work started in NeWater. In the project, innovative approaches to support learning processes across the science-policy interface to make European Water Policies climate-proof will be analysed. However, the focus will be on three levels (regional, national and EU) in just two countries.

A concerted action (Twin2Go) will synthesise insights into projects on adaptive governance and adaptive water management with an emphasis on climate change from a range of twinning projects. Lessons learned will be disseminated at higher policy levels in Europe and other world regions.

Policy entrepreneurs (individuals or organisations) play an important role in water transitions. The work on policy entrepreneurs is ongoing. With the support of other donors, insights into the effectiveness of various strategies of effecting such transitions will be developed.

Regarding the institutional prescriptions stemming from Adaptive Management (polycentric governance, participation, basin scale approach and experimentation), much more insight into political dynamics is needed. Relevant questions include: Under which circumstances are experiments acceptable to the public? How can we make sure that experiments do not turn into pilot projects? How can we guarantee a certain degree of openness of the questions that need to be answered throughout the experiment? How do we guarantee political support for the duration of the project? Similar questions could be asked for the other applications of AM.

The role of the financial sector in limiting losses due to climate change require further exploration.

Deriving indicators to assess the current level of adaptive management at the river basin level could be the next step in further elaborating on the framework for transboundary water management and information management and focusing on the institutional perspective. First attempts in this direction have been undertaken in collaboration with the Orange-Senqu Commission. Furthermore, it would be

beneficial to look at the mechanisms influencing transboundary cooperation at the local level through local case studies.

The technical approach and methodology of the link between spatial planning and land use change with water management has been demonstrated using the Waterwise tool, for instance, and has been acknowledged by the stakeholders consulted. The objective to apply the tool to real stakeholder settings in order to guide the negotiation process was not realised. Work will continue within the Nile Basin Initiative, which seemed to be the most promising project for continuation. The Nile Basin itself, comprising ten riparian countries where spatial planning processes take place (or not) at different paces and with variant priorities, was considered too sensitive for the objective of stakeholder support. For this reason, it would be better to concentrate future research at the sub-basin level, involving only a few countries. In this case, the focus could be placed on more specific issues, such as poverty alleviation, reduction of vulnerability and a recognisable scale for upstream – downstream interactions to support local and transboundary governance.

Two axes have been identified for further research related to buffering capacity management:

Developing indicators: hydrological and hydrogeological systems exhibit complex dynamics with important spatial and temporal heterogeneities. At the same time, adaptive water management relies on public participation, which requires concise and meaningful understanding of the natural system. Indicators are able to bridge this gap, as was demonstrated by their use in the construction of Bayesian networks. Further research is required to upscale the regional indicators identified in this work package to the national level.

Extending the concept of buffering capacity to the management of water quality and ecology: This work package only dealt with water quantity management. Further developments are required to link these approaches to other aspects of water management and to be able to propose a fully integrated management framework.

Due to time constraints, the Adaptive Monitoring Information System (AMIS) was only implemented experimentally in the Amudarya case study. A further important step regards the field implementation to support environmental monitoring in the case study. Implementation over a number of years will enable the validity of the proposed methodology to be tested to assure the long-term involvement of local communities in monitoring activities. Furthermore, the comparison between locally-based information and traditional monitoring data will provide useful feedback concerning the reliability of local knowledge and to introduce improvements in both data collection and analysis. In order to achieve these results, the field implementation of AMIS should be carried out for a few years.

Moreover, since the multi-scale approach is vital to AM, a further research requirement concerns the integration of alternative sources of knowledge, operating at different scales. The integration of locally-based information and remote sensing data is considered particularly interesting. Possible research questions include: How can these two sources of information be integrated? Is it possible to use their integration to support the cross-validation of information?

IV.2 WORK BLOCK 2 (WB 2): Vulnerability and adaptive management in the river basins

Leader(s): Pavel Kabat, Alterra, and Tom Downing, SEI-Oxford

IV.2.1 Objectives

In WB 2, the **vulnerabilities**, the **adaptive capacity of river basins** and the priorities to be addressed in adaptive management strategies were investigated, with a special emphasis being placed on the European Water Framework Directive and Water Initiative implementation areas. Concepts and case study results were to contribute to the development of methods to ease the transition to adaptive management in WB 1. More specifically, a conceptual framework for research into the adaptive management of river basins was developed in WB 2 that integrates natural science, engineering and social science concepts and methodologies. These concepts and tools were developed and tested in transboundary river basins, starting with a baseline survey of the actual vulnerability and adaptive capacity of river basins, which integrates exposure to present socio-institutional, economic and environmental stresses and shocks. A scientific foundation was elaborated for managing uncertainties, interactions across scales, integration across sectors and exposure to future stresses for climate resources, and conflicts between water quantity, water quality and ecosystem services. A range of **tools** was developed to **assess the vulnerability and adaptive capacity** that support transitions to the effective adaptive management of river basins. The influence of a system's structure and external shocks, stresses and trends regarding adaptive capacity, resilience and vulnerability was explored, under consideration of approaches that integrate poverty alleviation, gender awareness and health planning. **Scenarios** of the future vulnerability and adaptive capacity of river basins provide end points of transitions to adaptive management strategies.

IV.2.2 Progress toward meeting objectives

The distribution of objectives among the work packages is given in the following table:

Table 1: Distribution of objectives among work packages in WB 2

WP No.:	WP 2.1	WP 2.2	WP 2.3	WP 2.4	WP 2.5	WP 2.6
Objective No.:	1, 2, 7, 10, 11	2, 10	2, 10	1, 2, 5	1, 2, 7, 12	2, 13

In general, the team members involved in the work packages were satisfied with progress in the investigation into the vulnerabilities and adaptive capacity of river basins. They developed **practical toolkits** to set the baseline for understanding the priorities to be addressed by adaptive management strategies. The results (desk studies and field research) were shared with other partners, particularly those in WB 1.

All of the work packages in WB 2 focused on **applying NeWater knowledge and tools** in transboundary river basins, with a special emphasis being placed on the EU Water Framework Directive and Water Initiative implementation areas (objective 2). All of the work packages in WB 2 focused on applying NeWater knowledge and tools in transboundary river basins, with a special emphasis being placed on the EU Water Framework Directive and Water Initiative implementation areas (objective 2). They operated physically in the case stusy areas and to save resources later also more on-line and made considerable progress on their objectives especially in the second half of the project. The period of four years was generally considered to be short. The goals of the project were viewed as quite ambitious, because a lot of time was required to become established in a 'new' region, to adapt to each other's 'languages' and to develop a level of confidence in working with stakeholders in action research. Data availability was a problem for more advanced modelling, especially as the contribution of local stakeholders is often essential. Consequently, input may have been less accurate

and needed to be followed up by the local partner. In the course of the research, new interesting issues emerged that required continued support, which was also needed by the case study partners to ensure the introduction of the innovative concept of adaptive water management. It was observed in WP 2.5 that the NeWater project has a good tradition in the area which already feeds into other regional projects. In order to develop approaches that integrate poverty alleviation, gender awareness and health planning, WP 2.4 established links with IWRM. However, the full integration of poverty, gender and health issues in IWRM is a long-term process that requires effective political will.

In the Amudarya case study, a high level of interaction was attained in establishing a sound scientific foundation for managing uncertainties, interactions across scales, integration across sectors and exposure to future stresses for climate resources, conflicts between water quantity, water quality and ecosystem services. This cooperation was one of the main reasons why WP 2.3 focused on the Amudarya. Due to the high level of management of the Amudarya system, it was not easy to model the bio-physical system. However, the results and especially the approaches used are also of great interest to other basins. Due to a lack of proper local data, it was not possible to realise a study on the links between water quantity, water quality and ecosystems. Following the launch of the Ecological Flow Network website, it became considerably easier to manage interaction with organisations. In WP 2.2, the objectives on the climate investigation within the different river basins within and outside Europe were met. The analyses of potential climate change and associated uncertainties in the basins form a sound scientific basis for future studies. The goal of WP 2.6 to analyse scenarios of the future vulnerability and adaptive capacity of river basins in order to provide end points of transitions to adaptive management strategies was also achieved. The scenario work was even extended to all seven NeWater case studies.

IV.2.3 Major achievements

The greatest achievement in ‘Vulnerability and exposure to shocks and stresses in river basins’ (WP 2.1) was the development of **new tools to understand dynamic vulnerability and adaptive decision-making** in a variety of contexts, which were tested in basins relevant to the EU Water Framework Directive (Tisza and Guadiana) and EU Water Initiative (Orange). In Amudarya, locally used models were also integrated into the NeWater set.

A comparative study of potential climate change in most NeWater basins was conducted to obtain a better ‘Understanding of the consequences of climate hazards and climate change’ (WP 2.2). It was shown that river catchments will be affected differently. Although the warming trends are similar, the effects on the hydrological cycles within catchments will differ, not only with regard to mean changes but also to changes in extremes. A state-of-the-art land surface model was applied to the Rhine basin to investigate the effects of climate and land use changes on average and extreme discharges in the Rhine. The advantage of using such a ‘land-surface’ model to integrate climate scenarios is that it simulates land-atmosphere interactions in a direct physical, realistic manner. The **analysis of the coping strategies** shows that structural measures are in place in all seven river basins, but that the nonstructural measures are not very extensive and/or advanced. Success stories in dealing with climatic hazards and the lessons learned from them, taken partly from the seven case study basins and partly from the literature, are summarised and published.

In ‘Resolving conflicts between water quantity, water quality and ecosystems’ (WP 2.3), one of the major achievements was obtained in the Amudarya. Different techniques were developed and tested to clarify the impact of water quantity aspects on water quality aspects. The approaches vary from empirically derived relationships to process-oriented model approaches. For highly water managed river basins in particular, such as Amudarya, it was shown that it is possible to develop and apply strategies to reduce the impact of (at least) climate change on the ecosystem in vulnerable deltas. Truly adaptive water management will create even more possibilities to protect, e.g. nature, food production or hydro power capacity.

With regard to the environmental flow assessment, it became evident that a natural flow regime in water management is very important. A general framework was adapted and applied to the Amudarya basin. A network website (www.eflownet.org) was launched at the Brisbane International Environmental Flows conference in September 2007.

The 'Social dimensions of IWRM: poverty alleviation, gender and health' can clearly be linked with IWRM using tools for assessing dynamic water vulnerabilities which capture the relationships of poverty, gender inequality and ill-health to water management. Mechanisms were identified for the inclusion of poor male and female water users in multi-stakeholder dialogues and policy-making consultations to ensure that poverty, gender and health issues become part of the core operational procedures of the water management authorities at various scales of river basin management.

In the field of 'Resilience and adaptive capacity in complex water systems', WP2.5 produced a family of conceptual models that articulate stakeholder ideas about interactions between the ecological, economic and socio-political domains that influence the resilience of their river basin in the face of climate change. In addition, stylised quantitative models of stakeholder use of resources in river floodplains (both in the Tisza and the Amudarya river basins) were developed. Since models were co-produced by the stakeholders, their understanding improved, and it became easier to communicate in group discussions across the region. These activities culminated in an interactive game based on the Tisza river floodplain; stakeholders can play the roles of key actors in the economies of floodplains (water managers and farmers), exploring together the dynamic implications of their own decisions and the decisions of those around them.

In the development of '**Scenarios and future trends** in driving forces in IWRM' by WP 2.6, a rapid assessment matrix was developed for three case studies (Elbe, Tisza, Orange), which provides information on driving forces for the NeWater project. This matrix can be used as a tool for policy and decision-makers on assessing water allocation among users and the environment. It may also form the basis of a river basin sustainability index. Based on the rapid appraisal, trends were determined for a set of driving forces regarding the future development of water resources, water demand and water stress, and a related database was developed for the NeWater basins. The differences between the regions and scenarios were demonstrated on the future distribution of the global and regional freshwater resources, the human water demand and the occurrence of water stress. Application of the WaterGAP model showed regional views of changing conditions in the water sector for the seven NeWater case studies. A briefing document was compiled to serve as information and a guidance document for local authorities and stakeholders working in the case study areas

IV.2.4 Main messages

NeWater research into the vulnerabilities and adaptive capacity of river basins resulted in a number of messages:

Potential climatic changes will affect the hydrological cycles in the NeWater basins differently, which is why the changes have to be investigated separately for each basin. However, similarities are obvious for some of the basins, and experiences can be shared.

Although it is impossible to predict climate change, robust patterns and trends exist at the regional and seasonal scale that can no longer be negated. The uncertainties, which are associated with changes in emissions, limitations in global and regional modelling systems and internal variability, must and can be considered by way of ensembles projections, which are well underway for European and African climates

The effects of land use change on the streamflow of large river basins are very small because compensation mainly affects the sub-basins. The effects of urbanisation and deforestation, for instance, can only be significant locally and in small sub-basins.

The impact of the three investigated regional climate scenarios is considerable, causing more peak flows in winter and low streamflow in summer, especially in the second half of the 21st century. However, major uncertainties surround the emission scenarios, global and regional climate models, and bias the correction of their output, the hydrologic model and its parameterisation.

Water management related to extreme events is characterised by a high complexity, and involves uncertainty. For this reason, water resource management should be approached from a broad perspective, taking into consideration the interests of different related sectors, different spatial and temporal scales, and transboundary issues. This requires the application of the integrated water resource management (IWRM) method.

Moreover, projections of climate change and its impact on the water sector suggest that the goal of water managers should be to increase adaptive capacity to be able to cope more effectively with uncertain future developments rather than to rely only on finding optimal solutions.

The relationships between water quantity, water quality and environment flows can only be clarified using a fully integrative approach. For the highly managed Amudarya system, models were developed with sufficient management options for simulating the system dynamics. This may be easier in more adaptive systems.

In order to ensure that vital freshwater ecosystems function for the resilience and adaptive capacity for future generations, it is necessary to manage freshwater bodies in a more holistic way, by looking at water quality and water quantity simultaneously. Environmental flow assessments as part of IWRM could be one way of achieving this objective. The Environmental Flow Network accelerates learning about environmental flows and application of environmental flows in water allocation in river basin management.

Socio-economic development (including population growth) could have a major impact on future water stress as a consequence of considerable increases in water withdrawals. For the food sector, this may be compensated by imports. However, in many regions, these impacts are forecast to be a more serious cause of water stress than climate changes. It has to be pointed out that seasonal development of water stress and the future occurrence of hydrological extremes have not been analysed.

Some factors (such as population growth) could decline in importance over a certain period while others (such as climate change) could become more important. This is especially true for the second half of the 21st century, when climate change is likely to accelerate.

Vulnerability is not a static concept. Hence, while snapshots of vulnerability may be helpful at certain stages of the research process, they should be complemented by other tools and methods more appropriate to analysing the complexity and changing structure of vulnerability. This can be relevant for the biophysical assessment of river basins, as well as the socio-economic and more institutional aspects of the riparian countries and communities.

Social dimensions in water management are important for integrating local knowledge and social learning for adaptive IWRM. A bottom-up approach can be more effective in integrating poverty, gender and health issues. For this reason, there needs to be a focus on capacity building for local water managers supported by commitments from higher levels.

Action research requires large investments of resources simply to build trust and the understanding to sustain learning long enough to acquire new ideas. This requires that stakeholders are provided with a creative environment and that the assumptions they made when building group models are challenged.

Social modelling should be accelerated as much as possible to enable assumptions to be challenged. Otherwise there is a danger of simply confirming inherent assumptions, which can erect greater barriers to learning new ideas and practices for sustainable river management.

IV.2.5 Outlook

The comparative climate studies carried out within NeWater should be expanded to a multi-model ensembles system. At the end of 2009, the EU project ENSEMBLES will deliver a set of high-resolution climate changes scenarios using different global and regional models. These simulations, together with hydrological models, should be used to investigate not only the changes in hydrological cycles in the individual catchments of Europe but also the related uncertainty.

Hydrological modelling can be further improved. In terms of climate and land use change impact assessments, it would be interesting to carry out similar analyses in a setting where atmospheric and hydrological models are coupled interactively. Phenomena such as soil moisture feedback on temperature and precipitation can then be captured, which is not the case in the present analyses. In addition, inconsistencies still exist between the land surface component of the regional climate model and the hydrological model used. Solving these inconsistencies would make outcomes at the sub-basin level more certain.

Understanding and modelling a catchment of the size of the Amudarya is an ongoing process. It is the intended to continue the research into integration water quantity, water quality and ecosystems in cooperation with the EcoGIS Centre, which is part of the Institute of Irrigation and Melioration in Tashkent, and other partners. An iterative process between the hydrological model approach (at different spatial and temporal resolutions) and field measurements is required to improve the system analysis of a river basin and underpin the quality of scenario analysis.

Research into links between flow regimes, water quality and ecosystems should be given high priority as a basis for adaptive and sustainable freshwater management. Most freshwater bodies are confronted by a deterioration of water quality and flow regime, and these problems are likely to be amplified in the face of climate change. In the example of South Africa (Orange), stakeholder consultations were conducted on expected water availability, including the causes and consequences in the different countries, in order to discuss potential water-related adaptation strategies and the development of country-specific measures.

Regarding the simulation of global change impacts at the global and regional scale, a seasonal component needs to be introduced, i.e. consideration of seasonal water use instead of mean long-term water uses, and the impact of climate change on the seasonal distribution of water resources. Consideration of this element may increase the influence of climate change on water scarcity.

More interdisciplinary and holistic research needs to be conducted to support AWM. The analysis of water vulnerability should proceed in step with social vulnerability analysis. Dynamic vulnerability is naturally linked to adaptive management frameworks, extending a single-stress, sectoral focus to coupled socio-ecological systems. This is a challenge for adaptive water management, where water is linked to fundamental stresses in many sectors, economies and vulnerable socio-economic groups.

It is particularly important to capture the qualitative shift from one complex of vulnerability (e.g. resource-dependent self-provisioning livelihoods) to another (e.g. transient communities in economic and social relations at multiple scales). Specifically, this will require the development of innovative and participatory methods of research and guidance on the advantages of such methods compared to traditional ones. In addition, the robustness of river basin management will depend, among other things, on how it can incorporate local issues of water vulnerabilities, which are compounded with existing poverty and gender inequities together with environmental uncertainties, into various scales of operation. Further research needs to be undertaken to explore socio-technical barriers to the implementation of the generic mechanisms and tools developed by NeWater.

The interactive game developed by WP 2.5 requires a user-friendly interface so that it can be played by much broader groups across the region, thereby increasing the amount of knowledge elicited from stakeholders on the basis of their land use and river management decisions. And finally, the links

between science policy and policy operation need to be strengthened, alongside feedback from practices at local levels to science and policy. Action research methodologies would be particularly suitable for this aspect.

More access to data and field experience is required to improve the modelling of bio-physical and more political and socio-economic systems with more specific mathematical descriptions of relations/relationships and that allow better model calibration.

IV.3 WORK BLOCK 3 (WB 3): Case studies in river basins

Leader(s): Caroline Sullivan, OUCE, John Bromley, OUCE, and Olivier Barreteau, Cemagref

IV.3.1 Objectives

At the outset of NeWater WB3 was set two primary objectives. The first was to take the **tools** developed during the course of the project and to **assess their effectiveness** in the light of the requirements of the EU Water Framework Directive and Water Initiative. The second objective was to **develop and evaluate tools and procedures** to address the problems of **participatory research and stakeholder engagement** in the context of IWRM. Testing and evaluation of all tools and procedures took place in seven transboundary basins scattered throughout Europe, Africa and Asia. As it stands the current concept of IWRM does not take into account water management under conditions of uncertainty and lacks the facility to respond or adapt to rapidly changing environmental, economic and social conditions. A major element of the WB3 testing program was to assess the extent to which the selected tools and procedures were able to move the concept of IWRM in a more 'adaptive' direction, and be able to cope with the issues of integration, stakeholder engagement and uncertainty.

IV.3.2 Progress toward meeting objectives:

The first objective for the Work Block, the testing of tools and methodologies in the 7 case study basins, has been fully met. Table 4.1 lists the 28 tools, methods and procedures that have been applied during the past 4 years. The types of tool tested range from fairly conventional surface and groundwater models (e.g. MODFLOW and WEAP) to a range of participatory procedures from public participation workshops to cognitive mapping exercises. The list reveals the breadth and complexity of approaches that have been employed in the different basins in an effort to identify a way forward to introduce an adaptive element to IWRM in each of the basins.

So far as the second objective is concerned, the development of tools to address the problems of participatory research and stakeholder engagement in the context of IWRM, progress during the project has also been good, though not without problems. For instance Work Package 3.1, responsible for co-ordination points out that in practically all cases the collection of data was slow. The main delays stemmed from the slow progress of the stakeholder process caused by the need to build trust, and the unfamiliar approaches being applied by NeWater. Furthermore in the non-European basins (WP 3.6, 3.7 and 3.8) there was the unfamiliarity of many of the European partners with the cultural and political settings. However, it should be acknowledged that delay is almost inevitable when research programs depend upon the prompt response of a diverse group of stakeholders who have many other pressing duties and for whom time is of the essence. It was also pointed out by the Orange case study (WP 8) that progress in that basin was inhibited by a shortfall in input from European based scientists, partly because of the extra cost of travel to the region.

IV.3.3 Major achievements?

After 4 years WB3 can lay claim to having made a number of advances in the field of participatory adaptive water resource management. At a very general level the Work Block has helped to **bridge the gap between the theory and implementation** of the participatory process through the experience of the 7 case studies. Co-ordination of the WB by WP3.1 has identified two main criteria that are essential for the successful implementation of participatory research: the need to **promote and control information flow** from and to stakeholders, and the importance of the setting and of **interactions between stakeholders**.

Table 12: Tools applied, enhanced and developed during the NeWater project

Tool / Procedure / Methodology	Type	Catchments applied
WATERWISE	Model: Hydrology	*Rhine, Elbe, Nile*
Citizens' Juries	Participation procedure	*Rhine*
Participatory Scenario Workshops	Participation procedure	*Rhine*
Q-methodology Semi-structured interviews	Participation procedure	*Rhine*
HBV and SOBEK	Models: Rainfall runoff & hydraulic	*Rhine*
Matrix Scenarios	Participation procedure	*Rhine*
Cognitive mapping	Participation procedure	*Rhin, Orange*
Public Participation workshops; focus groups	Participation procedure	*All catchments*
SWIM	Eco-hydrological river basin model	*Elbe*
Drought severity indices PDSI, SPI, DS	Indicators	*Elbe*
Questionnaire surveys	Participation procedure	*all case studies*
Simulation Games	Flooding; Water allocation	*Elbe, Amudarya*
Bayesian Networks	Participation; DSS	*Guadiana*
GANetXL	Optimisation procedure	*Guadiana*
Water Footprint	Water Resource Evaluation	*Guadiana*
WEAP21	Model: Water evaluation & planning	*Guadiana, Tisza, Amudarya,*
MODFLOW	Groundwater Model	*Guadiana*
CART	Decision making	*Guadiana*
SIWAP	Model: Agricultural Economics	*Guadiana*
MIKE-SHE	Model: Catchment	*Guadiana*
Causal-Loop-Diagrams	Participatoy modelling	*Tisza, Orange, Amudarya,*
Knowledge-Elicitation Tools KnETs	Paricipator modelling	*Tisza*
Adaptive Monitoring and Information Systems (AMIS)	Monitoring System	*Tisza, Amudarya*
Group Model Building; Focus groups	Participation method	*Amudarya, Tisz, Orangea*
Modflow-Simgro	Model: Integrated Land - Water	*Amudarya*
AmuFish	Model: Water Flow Requirements	*Amudarya*
User Friendly Book of Scenarios	Participation procedure	*Orange*
Agricultural Catchments Research Unit model (ACRU)	Model: Agricultural water Use	*Orange*
WEThealth	Model: Wetland functions	*Orange*

Stakeholder Engagement: It is in the field of stakeholder engagement that NeWater has had the greatest impact. In all case studies significant steps were made in the development of tools, procedures and techniques to enhance the participatory process and to make it more amenable to the adoption of adaptive management.

In the Rhine case study (WP 3.2) a major success was the way in which researchers and stakeholders were able to interact and learn from each other. The result was that stakeholders were able to achieve their goals: a Water Management Plan for the Kromme Rijn, a Consensus Document for the Dhünn and a series of socio-economic scenarios for the Niederrhein. At the same time they developed their own participatory procedures based on interaction with NeWater researchers.

Significant strides forward in the Elbe basin (WP 3.3) were also based on a good working relationship between stakeholders and researchers. Based on the results of four sets of questionnaires and 4 stakeholder workshops, an integrated flood protection strategy was proposed for the Elbe. A notable

feature of the work was the success of a simulation game based on operational flood management; this was shown to be a powerful means to enhance understanding, interaction and collaboration between water management authorities, water experts and local stakeholders dealing with flood management.

For the Guadiana basin (WP 3.4) the major achievement has been to raise awareness for the need of adaptive management in the region and develop tools (e.g. Bayesian Networks) to support stakeholders. In the past a major stumbling block has been the distrust and conflict between stakeholders which made the selection and implementation of mutually acceptable management policies all but impossible. One of the very real accomplishments of WP 3.4 has been to bring together conflicting stakeholder groups and given them the opportunity to express their different views and opinions in an atmosphere of reliability and trust and to work together in water resources assessment. This process has enabled all parties to more easily understand and accept the position of others and to find solutions that are mutually acceptable.

A major accomplishment in the Tisza basin (WP3.5) has been the acquisition of new knowledge about water management complexity and uncertainties in the transboundary region. Two new participatory tools for floodplain management and flood risk decision-making have been successfully applied during the course of the project; Group Model Building (GMB) and Knowledge Elicitation Tools (KnETs). The first (GMB) is a method for analyzing data with a group of stakeholders where during one or more sessions a model of "the situation" is constructed in the form of Causal Loop Diagrams (CLDs). The second is the application of a Knowledge Elicitation Tool (KnET) to facilitate the participatory process. Through the use of interviews these tools provide a new way to reproduce and formalise local socio-environmental knowledge, while at the same time exploring future scenarios. KnETs departs from the classical empirical approach for qualitative social science research by adopting a flexible and interactive interview technique that results in a ‘game’ that is played in an iterative manner. Both approaches were remarkably successful in developing visions of the system that could be mutually acceptable to everyone.

In the Amudarya basin (WP 3.6) the degree to which stakeholders were prepared to engage with researchers in the process of system appraisal, development of management measures and tool development (e.g. WEAP, AMIS) was surprising. This must be set against the background of a situation in which the participation of Uzbek civil societies and other stakeholders in the policy process had basically been absent until the arrival of NeWater.

Cooperation and engagement with stakeholders at the transboundary level in the Nile Basin was facilitated through the use of the Waterwise model (WP 3.7). The process proved successful in the sense that the differences between neighbouring riparian countries were made transparent. However, it became apparent that transparency is not always welcomed in the negotiation processes because hidden agendas are likely to be exposed; something which stakeholders try to avoid. A further issue to emerge from discussions with transboundary stakeholders is that for a long term sustainable solution discourse in the Nile Basin needs to be widened to include economic cooperation between riparian countries as well as straightforward water management.

Finally in the Orange Basin (WP 3.8) all the concepts of adaptive management have been successfully introduced into the region. While it can be said that only a seed has been sown, it is anticipated that the impacts of this will be long-term and significant. Usefully, the project team have been appointed to write policy in South Africa which includes adaptive management, so the prospects of this thinking becoming incorporated into management are good.

Role of models: In all basins models of various types were introduced to help advance the introduction of adaptive management. Some dealt with flooding, others with water quality. In the Elbe various modelling approaches applied to the catchment proved to be decisive for the identification of the fraction of point and diffuse sources at the outlet of a river system and the location of highest diffuse pollution (hotspots). Knowing the fractions and hotspot areas made is easier to identify useful

measures for reducing nutrient loads in the river network and for achieving the "good ecological status" required by the WFD. For the Nile (WP 3.7) the introduction of the Waterwise model facilitated the investigation of this complex basin and helped structure the process of trans-disciplinary stakeholder consultation. Waterwise is an integrated model which links the hydrology, economy and ecology.

Wetland ecosystems: In two basins, the Amudarya and Orange the vulnerability and valuation of wetland ecosystems proved to be a significant achievement. In the Amudarya an economic valuation was used to identify ecosystem services of wetlands and an analysis of wetland ecosystem vulnerability was undertaken. This linked directly to the planning and implementation of a wetland restoration project currently being undertaken by the Uzbek government. Moreover, NeWater transferred new ideas such as the role of uncertainty and tools such as AMIS to the scientific and practitioner communities in the river basin. Another wetland evaluation exercise was completed in the Orange basin. This had previously been an area of major knowledge deficiency in the region and was an issue that was highlighted at an initial stakeholder workshop; the impacts of this information are already being experienced in the basin and in other places.

Hydrological Scenarios: A particularly significant step for adaptive management was made in the Orange Basin where a series of hydrological scenarios for the region were developed and coupled to an estimation of water vulnerability. Such information is essential if adaptive management is to be properly implemented. The work that was done for NeWater has been extended to the rest of South Africa and is sure to become crucial information for management in the basin. There were already expressions of interest from the likes of the transboundary basin commission (ORASECOM), DWAF and the Water Research Commission.

Finally it should be noted that it has not been possible to implement full scale change in any of the basins in the short amount of time available to the project. However, by introducing the concepts of adaptive management NeWater has sown a seed from which new and more appropriate tools will ultimately emerge to embrace these new concepts.

IV.3.4 Main messages from WB3

During the course of the project many lessons were learned and a great deal of experience gained by WB3 participants. From these lessons a number of messages for future research projects and for water managers the world over can be given. These include:

The experience of WP3.1 was a feeling that in some senses participation has certainly become fashionable. It has spread into research in the same way that it has spread into policy making. Despite considerable progress, not unlike in policy making it remains much easier to talk about participation than to actually do it. Much change and learning – among researchers and policy makers - is still required to move towards projects that are equally meaningful not only for these two groups but also for the users of the research such as farmers, ecologists and other water users. Learning needs to occur not so much on the level of methods and tools but more on the more difficult to change level of attitudes. Taking into account usually quite diverse stakeholder needs requires empathy, the willingness to put one's own agenda on a back burner for some time, as well as patience and time. This is not to say that classical research is inferior because of the absence of a participatory element; what kind is used should depend on the specific objectives in a given case.

The time and resources required to carry out a worthwhile participatory process should not be underestimated (WP 3.2). Sufficient time, money, skill and patience need to be committed to ensure a successful engagement process; trying to cut corners is a recipe for failure. Another important requirement when dealing with stakeholders is the necessity to create an atmosphere of trust, particularly in cases where conflict is long standing and bitter. A good example of this type of conflict was encountered in the Guadiana (WP 3.4). In some areas such as the Tisza (WP3.5) a strong message

is the need to increase the degree of coordination between different sectors such as agriculture, the environment, navigation, and flood defense. The implementation of integrated management cannot be achieved without collaboration and coordination between sectors. In some basins (e.g. Tisza and Amudarya) economic weakness and dependence on national budgets currently endanger positive developments and opportunities. On a positive note it is encouraging that a great deal of research and effort is now being made to help implement the requirements of IWRM, through the WFD. In the Tisza for example there are currently two large research projects taking the place of NeWater; (ADAM – www.adamproject.eu, and SCENES – www.ymparisto.fy/scenes, CLIMATEWATER – www.climatewater.org).

One message runs through all the NeWater basin case studies; the problem of uncertainty and how to cope with it. Wherever IWRM is being implemented uncertainties need to be recognised and strategies to cope with them developed. Such strategies have been developed during the project (WP3.6). There are no simple, large scale technical solutions to the complex problems of the river basin. Future water management should be more adaptive, as we are living in a rapidly changing world; scenarios of possible futures should be taken into account (WP 3.3, 3.6, 3.7 and 3.8). In addition to these general messages the value of a whole range of tools, techniques and models applied to each basin have been highlighted by the different work packages. Just a few of these include stakeholder engagement techniques (WP 3.2), Eco-hydrological modelling (WP 3.3); the Water Footprint and Bayesian networks (WP 3.4); Group Model Building and KnETS (WP 3.5); the application of WEAP and AMIS (WP 3.6); the use of Waterwise (WP 3.7); and finally hydrological modelling and scenario setting (WP 3.8).

IV.3.5 Outlook

At the end of 4 years of research into Adaptive Management the question is where do we go from here? What is the outlook and what measures need to be taken to ensure that AM is successfully implemented throughout the world? Below are a number of ideas for future research and implementation procedures drawn from all the WB3 case studies.

One suggestion is that a standardized tracking protocol needs to be introduced for participatory processes, one that is acceptable to all participants. This would provide an indication of the degree to which the process has been successful or not. Currently it is difficult to assess the success or otherwise of an engagement process except in very subjective terms; a standard protocol to measure performance would be a step forward.

Staying with the subject of participation it seems that in future one way to break down rigid administrative structures is through the increased involvement of stakeholders in the decision making process wherever possible. The more stakeholders are allowed to develop a sense of ownership in decisions, the more likely it is to be successful. One benefit from this approach is that it generates a much greater degree of transparency in the procedure and helps foster trust between the participants; moreover it also provides a better framework within which to resolve potential stakeholder conflict. Many of the tools and procedures applied in WB3 have made strides in this direction (e.g. Bayesian networks, Group Model Building).

Perhaps one of the most striking facts to emerge from NeWater is that adaptation planning is not neglected through a lack of knowledge of adaptation strategies, but rather due to a lack of institutional and financial capacity to undertake these options to their maximum benefit. Future emphasis should be placed on drawing on the current strengths of the community through, for example, local community groups, social networks, the Church and through the use of innovative information communication technologies (ICTs).

Two of the NeWater basins are currently undergoing a transition from a rigid communist regime to a more open capitalist system. This is posing many problems and more research is needed to assess the

way in which different stakeholders are affected by this transition and to determine who carries the cost. Furthermore the most appropriate mechanisms to achieve transition need to be identified.

Another issue to emerge worth noting is that NeWater has emphasized the importance of working at the scale of the sub-catchment when dealing with adaptive management, uncertainty, climate change and population pressures; simply concentrating on the large transboundary catchments is unlikely to provide solutions.

Finally the main finding of NeWater is that adaptive management remains an untapped message that now needs to be strongly broadcast to stakeholders. It is most unfortunate that the project should finish just as the most interesting and useful information was beginning to emerge. The greatest challenge will be how to foster the adoption of adaptive management in the minds of catchment managers, who all already believe that they practice this but clearly do not. There is a pressing need for the EU and other international bodies to fund a training process that incorporated findings from many IWRM projects, including NeWater, and then work towards the incorporation of this into national training schemes.

IV.4 WORK BLOCK (WB 4): Guidance and tools for practitioners

Leader: Hans-Jørgen Henriksen, GEUS

IV.4.1 Objectives

Work Block 4 involved wide-ranging activities, such as liaising with overall project management and other work blocks and packages; synthesising the findings from WB3 case studies (WP4.1); extending and developing tools for IWRM to supplement existing ones (WP4.2); and associated training package development, implementation and dissemination activities (WP 4.3). The aim of the work block was to build upon and extend the progress in water resources development made on the basis of previous and current EU funding, in particular FP5, and the Global Water Partnership (GWP). For the development of **tools and best practices** to be sustained to the point of reliable and effective end use, it is important that Work Block 4 functions as an **interface between theory and practice**, **development and application**, researchers and practitioners.

IV.4.2 Progress toward meeting objectives

Work Package 4.1 contributed to two of the objectives set for Work Block 4. The first was Objective 6: To develop a range of tools to assess and manage the transition to adaptive management tailored to the institutional, cultural, environmental and technological settings of river basins. All the reports provided the background data on which tool development and enhancement were based. The second objective was Objective 14: To deliver a comprehensive methodology and protocol for its use that demonstrates the best practice in using innovative tools for adaptive management drawn from the NeWater case studies. The work package identified the needs and requirements for new and enhanced tools that were developed in other parts of the project.

WP 4.2 mainly contributed to the Objectives 6: To develop a range of tools to assess and manage the transition to adaptive management tailored to the institutional, cultural, environmental, technological settings of river basins; Objective 15: To develop an innovative toolkit and guidance for practitioners in applying methods for the adaptive water management of river basins; and Objective 17: To initiate an world-wide research to application platform for effective scientific and cross-policy cooperation in dealing with the high complexity and limited predictability of integrated water resources management on a river basin scale that contributes to constructive dialogues with the Global Water Partnership (GWP), World Water Council (WWC), International Union for the Conservation of Nature (IUCN)

and other efforts have been met by the deliverables and synthesis products (SP 9 Guidebook, SP 10 Portal and the new tool: SP 2 Uncertainty Guidelines) in which WP 4.2 was involved, in a form appropriate for the intended readership/audience.

In WP 4.3, the progress towards objective 15: To develop an innovative toolkit, guidance and training materials for practitioners in applying methods for the adaptive water management of river basins has been successful. This has been the result of a very positive and intensive cooperation and a form of project management that incorporated both frequent meetings at partner institutions and a substantial number of telephone conferences using Skype and GotoMeeting IP tools. The first allowed effective project phone conferences, which were held frequently. The second also allowed mutual presentation of documents for discussion and editing.

IV.4.3 Major achievements

Work Package 4.1 delivered three reports related to existing water management practices in each of the seven case studies and to the need for new and enhanced tools for the better implementation of IWRM. First, a review of current IWRM practices in the NeWater Basins identifying the degree to which IWRM are currently being implemented in each region and lessons learned in the attempts of

introducing IWRM and needs of tools for supporting the implementation. In addition legal, political, historical, financial and social barriers for practicing IWRM were identified (deliverable 4.1.1). Second, deliverable 4.1.1 and results of work in WP 4.2 regarding state-of-the-art of IWRM tools (see WP 4.2) guided a review of end user needs for enhancement of existing tools (deliverable 4.1.2a), to make them more effective as means to implement IWRM. Third, a review of the need for new IWRM tools in each basin, again based on a canvas of local end users and stakeholders, was provided (deliverable 4.1.2b). The sequence of the three reports provided a comprehensive survey of the state of IWRM implementation in the NeWater case studies with assessment of the type of tools that were needed to help improve the situation. The contents of the reports provided a foundation for the subsequent structuring of tool development (in WP 4.2) and development of training material (in WP 4.3). In a wider sense, particularly deliverable 4.1.1 provided a **snapshot of the contemporary state of IWRM** and needs for tools in case studies located in three continents, with future development of IWRM gauged against this base line evaluation.

Over the four years, the WP 4.2 produced four major research outputs: First, a state-of-the-art review of tools used for IWRM (deliverable 4.2.1) and in need of enhancement to meet the requirement of adaptive management. This review has guided the subsequent work of WP 4.2. Second, a set of enhanced tools designed to meet the case study requirements and to fill the gaps described in the review report (deliverables 4.2.2 and 4.2.3). Third, a **Guidebook for Adaptive Water Management** with practical advice for policy-makers, water managers and civil society organisations is produced in close collaboration with the seven case studies (WB3) and the other WBs in NeWater. An agreement has been made with Earthscan for publishing a printed version of the NeWater Guidebook on adaptive water management (Synthesis product no. 9). The agreement, however, does not preclude the project from distributing the electronic version of the Guidebook from the NeWater web portal for free. Fourth, the NeWater AWM section in WISE-RTD, which summarises all practical outputs of the projects to build a separate component of the EU research portal WISE-RTD (Synthesis Product 10 NeWater portal). The very close collaboration with the seven NeWater basins and the interaction with other synthesis product developments have proven to be very valuable for crystallising experiences and lessons learned about possible supporting AWM tools and learning processes for system thinking, experimental work, social learning, leadership, institutional support, etc., which can lead to better informed and qualified scenarios for likely futures, where engagement of stakeholders, beyond the levels of information and consultation are needed, and where experiments and the use of a diversity of tools can make systemic learning, integration and uncertainty analysis more efficient and thereby provide new and useful dimensions to IWRM.

The major achievements in WP 4.3 have been, first, the development of training material for evaluation in all (7) NeWater **Train-the-Trainer** (TtT) workshops, including conducting a Train-the-Practitioner (TtP) workshop in the Guadiana basin, in which TtT trainees have contributed to the dissemination of their knowledge on Adaptive Water Management to other stakeholders. Second the development of a Training Booklet in support of the transition to a more adaptive water management. The training booklet is accompanied by a CD that includes an electronic, hyperlinked version of the booklet from which all relevant documents are accessible. The booklet contains material developed in other NeWater work packages, i.e. i) the Online Curriculum (WP 6.3), targeted towards a more academic oriented audience, and ii) a link to the NeWater Portal (WP 4.2) as embedded in the EU WISE-RTD, accessible to a wide range of water professionals. Finally, a link from the Global Water Partnership (GWP) portal makes it possible to access the developed training material through the NeWater Portal.

IV.4.4 Main messages

The results of the WP 4.1 revealed that while the majority of basins in the NeWater study accepted the principles of IWRM, and indeed incorporated them within legislation, in practice the degree of implementation ranged from ‘not at all’ to ‘very little’. Problems ranged from the need to completely

reform the institutional structure to providing improved techniques to engage stakeholders in the decision-making process. In every case, the call from practitioners was to provide tools that can:

(a) be used to integrate across disciplines

(b) help to engage stakeholders in the decision-making process more effectively and,

(c) cope with the problem of uncertainty

The NeWater project has made the first steps toward delivering these tools.

The main messages of WP 4.2 are advice on how to put flexible and adaptive water management in place. These messages are summarised in Chapters 1 (Executive summary) and Chapter 13 (Summary and Outlook) of the NeWater Guidebook (SP 9), and formulated as five policy recommendations (metaphors):

1) Build capacity: Effective leadership and sustained financial support are crucial. Horizontal and vertical coordination and harmonisation are essential to facilitate change (Lighthouse metaphor).
2) Commit to uncertainty: Integrated and forward-looking approaches need to take into account new realities and challenges. Short and long-term scenario analysis can inform policy and specify learning goals. Commitment to uncertainty results in robust policies (Explorer metaphor).
3) Think twice before deciding. Diverse tools are needed to explore vulnerability and resilience, encourage systemic learning and create opportunities for adaptive water management (Apparatus metaphor).
4) Dare experiments: Experiments can be put in place at different institutional levels. Successful small-scale pilot studies can help to instigate new management approaches. Integrated performance and compliance assessment require apposite monitoring (Researcher metaphor).
5) Plan for adaptation: Stakeholder engagement, education and the creation of bottom-up user associations are crucial steps to attaining adaptive surface and groundwater management (Nurture metaphor).

The main messages of WP 4.3 are that tools, principles and practice of transition to a more adaptive water management can be disseminated to, i.e. taught to, water managers and basin practitioners by training. This has been tested in TtT workshops. This requires that training material is developed for the specific group and that the tools are selected for use in that specific stage within implementation of adaptive water management. Under the NeWater conditions there was a clear interaction with the participants stakeholders by i) involving stakeholders in identifying needs for adaptive water management and ii) using stakeholder feedback, to further enhance and improve developed training material.

IV.4.5 Outlook

The outlook for each NeWater basin is different and depends on the political, social, economic and cultural conditions prevailing in the region. In the case of the AmuDarya and Nile, there are enormous transboundary issues that need to be resolved before IWRM can successfully be implemented. Clearly, in these two areas the next steps are to provide a political, economic and social framework within which IWRM can be initiated. However, it is inevitable that this process will be long and not without setbacks. In the case of the remaining five basins, transboundary issues are also an issue, but are less of a barrier to the eventual implementation of integrated management.

It is clear that in all basins, more tools to enable more effective integration of stakeholders in the decision making process are required. This in an area of future research that should be expanded, because without stakeholder involvement any decision-making process, no matter how well founded or sophisticated, is unlikely to be successful. Another area of research that requires more attention is the development of tools that can be used to integrate data drawn from different disciplines. A few techniques such as Bayesian networks and the WEAP model have been introduced during NeWater, but much more development and research is needed in this area. Finally, as mentioned earlier, the problem of uncertainty is one that many practitioners find difficult to handle. By and large, uncertainty is currently regarded to be undesirable and to be overcome at all costs. However, there is scope for research that will enable managers to accept uncertainty and to incorporate the issue as part of their adaptive management approach.

As the next step, we envisage a set of activities to increase the public ownership of the NeWater research results. The site-specific character of the climate change impacts and the persistent uncertainty make it critically important to design policies which are robust enough to perform reasonably well under not entirely known future conditions. The policy making also requires that more discretional power is given to public authorities and agencies and flexibility to undo decisions which turn out badly without losing all the process up to that point. The larger discretion needs to be counterbalanced by extended public oversight. In this context, the research outputs of WP 4.2, particularly the Guidebook and the Portal, will make adaptation policies better informed and assist public oversight of the policy implementation. A continuation of this work with the Guidebook and Portal is highly desirable. It is evident that the lessons learned, and identified intermediate outcomes of piloting AWM, the values of the tools and initiated learning processes by NeWater, are difficult to evaluate after only four years, and that additional follow-uup research could further qualify the Guidebook and Portal, especially within areas where AWM provides new dimensions to IWRM (uncertainty and learning from experiment).

The WP 4.2 partners plan activities beyond the project horizon to facilitate the uptake and dissemination of the research results achieved. For example, RBA plans to include summarised experiences gained from the training workshops in a PhD thesis to be finished in 2010. CRAN plans to incorporate material and knowledge from WP 4.2 into their existing Masters level courses. USF intends to create guidance on how to record results in the AWM section and GEUS plans to incorporate results from NeWater into national research projects and guidance material targeting climate change adaptation and groundwater-surface water interaction in relation to recently initiated Interreg projects in the North Sea (CLIWAT) and Baltic Sea regions (BaltCiCA). Further, the developed training material needs to be tested and further enhanced in NeWater basins as well as in other river basins. From the TtT workshops we learned that there is a strong need for application of the training material in the regions. To make the material tailor-made for this kind of stakeholder training, the NeWater partners remain available for further cooperation with the trained staff.

NeWater produced considerable material for the training of water management practitioners. It would be useful to find additional funding to organise training courses to support capacity building and to develop courses tailored the need of specific world regions, as strongly expressed by participants from summer schools and training courses, in particular Central Asia and Africa. For many, IWRM was more an administrative burden than a way to solve practical (local) problems. In such areas, IWRM may not have been practiced as much as it could have been. Here, the option of using AWM could also be appealing. In fact, some of the experiences from NeWater, e.g. from the Nile and Amudarya, seem to have helped water managers and stakeholders to realise, after piloting AWM, that the IWRM approach is useful and needed.

IV.5 WORK BLOCK 5 (WB 5): International expert and thematic platforms

Leader: Pavel Kabat, Alterra

IV.5.1 Objectives

The function of WB 5 within NeWater was to initiate **global research** into an application platform for **effective scientific and cross-policy cooperation** in dealing with the high complexity and limited predictability of integrated water resources management at river basin scale, contributing to constructive dialogues with organisations such as the Global Water Partnership (GWP), World Water Council (WWC), International Union for the Conservation of Nature (IUCN). Further, the platform assessed current practice in IWRM and drew lessons for the transfer of new scientific methodologies for IWRM practitioners. Finally, it supports initiatives to **share experience and innovations** in dialogues, publications and action, to further the European Research Area and to support the implementation of the Water Framework Directive and EU Water Initiative.

IV.5.2 Progress towards the objectives

With regard to global dialogue (objective 17), the platform established intensive cooperation with the Global Water Partnership (GWP) on the testing, review and application of the NeWater training tools, which were integrated into the revised GWP toolbox. The dialogue with the World Water Council (WWC) was effectuated by participating in both conferences of the World Water Forum in Mexico (2006) and Istanbul (2009). In Mexico, a session was organised with contributions from the Global Water System Project (GWSP) and the Cooperative Programme on Water and Climate (CPWC). There was also active participation in annual conferences of, e.g. IHDP, GEWEX and Stockholm Water Week, where an expert meeting was organised in 2005.

More specifically, the platform contributed to the assessment of current practice in IWRM and drew lessons for the transfer of new scientific methodologies for IWRM practitioners (objective 8) by publishing a book entitled “Adaptiveness of IWRM”. This book provided a description of the state of the art in European research in specific disciplines, and placed this situation vis-à-vis the expected challenges for future water management situations under uncertainty. Preparation for the book and the policy briefs promoted debate among experts on the various topics with an outreach to the policy arena via the policy to science day at the first International Conference on Adaptive and Integrated Water Management (CAIWA) (in cooperation with WP 6.2).

The platform also supported initiatives to further the European Research Area and to promote the implementation of the Water Framework Directive and EU Water Initiative (objective 16). These activities were very much based on initiatives from within and outside NeWater with a focus on contributions to conferences, as well as the organisation of and participation in training workshops, setting up intercontinental research cooperation, such as with Australia and the USA, and related synthesis products, documents and policy briefs.

To make the platform more effective, the budget was moved mid-term from Alterra to Wageningen University, mainly to avoid the contractual aspects of co-financing, which led to unexpected financial and administrative problems. Such problems made the programme time-consuming and less accessible, especially to some international NGOs and participants from developing countries.

Table 23: Overview of international organisations that (in)directly participated in NeWater platforms.

Organisation / Expert group	Relation to NeWater Project
Global Water Partnership (GWP)	Overall IWRM thematic network; Dissemination through website and regional basin networks: Inclusion of NeWater case experiences in the GWP Toolbox; Creation of a NeWater partner section in the GWP Toolbox to disseminate main project results
World Water Council (WWC)	Cross-sectoral and governance issues in water, participated during WWF4 in Mexico and WWF5 in Istanbul
Global Water System Project (GWSP) of the earth System Partnership (ESSP)	Water system studies at different scales; synergy between natural and social sciences; international water research agenda
International Geosphere-Biosphere Programme (IGBP)	Water cycle and water management issues in global change in a biochemical context
Global Energy and Water Experiment (GEWEX) project of the World Climate Research Programme (WCRP)	Water cycle and water management issues in relation to climate variability and climate change and their regional user workshops
International Human Dimensions Programme on Global Environmental Change (IHDP)	Water cycle and water management issue in relation to human dimension issues
DIVERSITAS	Water cycle and water management issues in relation to biodiversity
Collaborative Programme on Water and Climate (CPWC), follow up of the Dialogue on Water and Climate	Coping with climate change & variability in water management, tool development; local participatory adaptation agenda in river basins
GUND Institute for Ecological Economics, University of Vermont	Global Change modelling, ecosystem services, environmental economics
International Union for the Conservation of Nature (IUCN)	Member of the NeWater Consortium; Ecology and Biodiversity
UNESCO IHP	International Hydrological Programme
UNESCO IHP	Platform partner for co-research Coordinator Australian based international network of excellence on catchment management
CSIRO Australia	International network on Adaptive management, human-ecosystem interaction
DHI Water & Environment	Cooperation with GWP on training material and Website; Technical developments; engineering, water management modelling
Gender and Water Alliance (GWA)	Gender and Poverty Alleviation Issues in IWRM; various case studies;
International Groundwater Resources Assessment Centre (IGRAC)	Groundwater management and IWRM; transboundary groundwater
International Institute of Applied Systems Analysis (IIASA)	Member of the NeWater Consortium; integrated assessment, global change
International Water Association (IWA)	Link to water professionals world wide. Communicating create innovative, pragmatic and sustainable solutions to challenging global water needs
International Water Management Institute (IWMI)	CGIAR Challenge Program on Water & Food; ongoing work in case study areas

Organisation / Expert group	Relation to NeWater Project
National Institute for Land and Infrastructure Management, Tsukuba, Japan	Water management and spatial planning, flood risk mitigation strategies
Nile Basin Initiative (NBI)	Cooperation programe of the 10 Nile coyntries; Case study partner in Nile
Stockholm Water Institute (SIWI)	Organisation Stockholm World Water Weeks, water policy think-tank
Stichting Global Infrastructure Research Foundation Europe (GIRF)	Improvement of large scale infrastructure, transfer of innovative techniques to consultants & contractors
UNESCO-IHE	International Water Education; capacity building in developing countries & countries in transition
University of Washington, USA	Platform research partner on Hydrological issues.
University of Texas	Implementation Water Framework Directive in former Eastern Europe
Water UK	Wastewater sector & Sustainable water resources management

IV.5.3 Major achievements

The work block "International Expert- and Thematic Platforms" focused on the 'European IWRM to Platform' as well as on the 'Global IWRM research to Application' platform. The main tangible achievements were the '**Science to Policy' day** at the CAIWA conference in 2007. Entitled 'Adaptation to climate change in the water sector', seven roundtables were organised on prominent EU water issues and tailored to the conditions in the river basins of the Rhine, Guadiana and Orange. A **book entitled "The Adaptiveness of IWRM"** that assesses EU research into adaptive water management was launched at this same event. Three summer school events were organised in cooperation with GWSP. At these events, young scientists shared their opinions on theories, concepts and applications of adaptive water management. International research cooperation on institutional conditions for groundwater and surface water management was established with the Australian National University, and on the effects of climate change river flow with the University of Washington. The main NeWater resources that are relevant to practitioners have been integrated into the **GWP toolbox**, where they remain accessible and open for up-dates for the near future. This accessibility was the result of intensive cooperation between the platform, work block 4 and GWP for the testing, reviewing and application of NeWater concepts and tools in Train-the-Trainer workshops in the regions. More support was given to synthesis products and the dissemination of Newater results.

Less tangible are the results of the numerous (approximately 50) requests and proposals for support of complementary activities to achieve a specific AWM input or to effectuate a wider outreach, such as for developing countries. The results are evident in the quality of the end product and in the increasing awareness for adaptive water management in developing countries.

IV.5.4 Main messages

Programme activities, such a platform. are effective due to their small but specific contributions to ongoing activities, as they can establish a creative environment and enrich the research work. In this way, exchange was established between research in the consortium and external developments.

The platform shows that there is a wide variety of understanding of the concept of adaptive water management throughout the world. In some water systems, the approach has already been used for quite a long time. In other areas they only apply a single aspect of AWM. In many other countries, AWM has not yet become mainstream. However, awareness among scientists, policy and practitioners

is growing. Experience in platforms also shows that people do experience climate change and that they are receptive to the concept of adaptive water management, but still lack the urge to implement it in their management system. The Australian research shows that conditions for adaptive water management can be very different and that transition to a more adaptive and decentralised regime requires centralised processes.

The 'European Platform' specifically mobilized a variety of people outside the NeWater community to reflect on the strengths and weaknesses of the current paradigm of IWRM in water management. It came to the conclusion that IWRM accounts for most of the challenges faced under conditions of uncertainty but still requires more effective implementation. Furthermore, it is concluded that IWRM falls short in including people in a process of learning and experimentation, which is needed for us to be able to face future challenges.

IV.5.5 Outlook

As stated above, further testing and applications of concepts and supportive AWM tools will be useful in many countries. At intercontinental level, it will be beneficial to their long-term research programmes to follow up the cooperation initiated in Australia and the USA. The work in the case studies also requires support. At the country and basin level, continuous attention should be given to stimulating dialogue and capacity building on adaptive water management. NeWater tools introduced during Train-the-Trainer workshops can be integrated by, e.g. GWP and IUCN in their local projects. Participants in the Train-the-Trainer workshops than can apply the knowledge learned and adapt NeWater concepts and tools to the local situation, while sharing their insights with stakeholders in the respective area.

In the course of the analysis of IWRM research, an attempt was made to broaden the scope towards national IWRM research. Unfortunately, this was not envisaged in the DOW and, due to capacity constraints, could not be realised as an add-on to the project. Since the role of AWM to IWRM is clearer at the end of the project, and more examples of working towards adaptation to climate change are available, now is the appropriate time to extend the scope to national IWRM research, as well as to research outside the EU. With regard to the results from this work package, the most pressing research needs refer to water management as the major adaptation medium for climate change.

IV.6 WORK BLOCK 6 (WB 6): Management and project internal coordination Platform

Leader: Claudia Pahl-Wostl, USF

IV.6.1 Objectives

WB 6 of the NeWater project dealt with the **management and coordination of the whole NeWater project**. Besides the initiation and maintenance of the project management office (WP 6.1), the task of the WB was to coordinate and supervise the implementation of dissemination activities (WP 6.2). In addition, one major task was the "Development of a Training programme and Summer Schools and the Development of University Curriculum" (WP 6.3).

Specific objectives at the outset of the projects were to share experience and innovations in dialogues, publications and action, to further the European Research Area and to support the implementation of the Water Framework Directive and EU Water Initiative (objective 16 in cooperation with WBs 3 and 5). A further objective was to initiate world-wide research into an application platform for effective scientific and cross-policy cooperation in dealing with the high complexity and limited predictability of integrated water resources management on a river basin scale that contributes to constructive dialogues with the Global Water Partnership (GWP), World Water Council (WWC), International Union for the Conservation of Nature (IUCN) and other efforts (objective 17 in cooperation with WB 5).

IV.6.2 Progress towards objectives

The NeWater project consisted of 38 partners, whose work is strongly interlinked. It required a project development that also lives from iterative processes in order to achieve innovative and sound results; all of these changes were absolutely reasonable and improved the project capacity. WP 6.1 was faced with the challenge of handling the overall operational management of the project. It reported to the project coordinators and offered services to not only work block and case study coordinators but also to all project partners. Further, the project management supported the project coordinators in the supervision of the scientific, technical, financial and administrative progress of the project and in coordinating relations between the partners and implementing an efficient management and coordination of the project. Furthermore, all administrative aspects, such as financial issues, reporting and the organisation of the platform and project meetings, were the responsibility of the project management. From the organisational perspective, such as changes in the consortium or the composition of work blocks and work packages, it must be emphasised that no major changes were made throughout the project period. Only two partners left the project in the course of the entire project duration. Three new partners entered the project. One of these partners did not request any EC contribution, the second new partner took over the project tasks of one of the partners who had left and the third partner had to enter to project as a new partner due to an internal merging process. All in all, the number of about 37 project partners remained stable over the entire project duration. Also, the numbers of work blocks remained the same; only two work packages were merged. Only a few contract amendments and budget reallocations were requested to improve the distribution of partners' capacities, and thus the quality of the project results. Considering the above-mentioned complexity of the project, all of these changes were absolutely reasonable, and improved the project capacity. After the third project year, the original project manager left the NeWater project. Accounting for the additional resources to take over a management process at the end of the project and considering the constant overload with the work of the former project manager, the resources of the project management were increased by 70%. This increase led to two people performing the work. The increased capacity definitely supported the successful scientific and administrative finalisation of the

project. The support given by the European Commission upon the request of the project management was also beneficial to the success of the administrative process. In the last third of the project, stronger attempts were made to improve the quality of the NeWater deliverables. The new project management thus initiated an internal review process for selected deliverables, and gave higher priority to the logistics of the deliverables in terms of due dates, layout and dissemination.

The role of WP 6.2 was to coordinate and disseminate the final scientific synthesis of the project results and to guarantee the development of joint products for the scientific and policy communities. WP 6.2 supported the dissemination of project results, initially by developing a marketing concept for NeWater products (logo, timing, target groups), and by editing, publishing and disseminating an electronic NeWater Newsletter and NeWater Policy Briefs. The development of different special issues, three books and numerous peer-reviewed papers, almost always with multiple authors, shows that the WP succeeded in establishing a successful publication policy. The website was continuously updated to disseminate the results and communicate the process of the project. Two flyers were developed and printed: the first provided a general description of the project, while the second at the end of the project gave a compact summary of the project results. Targeting water policy makers, a 15-page information brochure on the main project results with a professional layout was developed. The latter two were also translated into various languages. Further, the organisation (in cooperation with WP 6.1) of two conferences, namely the CAIWA and the final NeWater conference, provided two important platforms for disseminating NeWater results and for knowledge exchange between researchers, water managers and policy-makers. Also NeWater participated in all major water conferences in the past four years (Stockholm Water Week (every year), World Water Forum 2006 & 2009, International Water Associations, European Water Conference 2009) with sessions, presentations, posters and/or information material.

A central task of WP 6.2 was the initiation and coordination of the synthesis process, which has to be understood as a joint effort by all NeWater partners. While the formal part of the review of NeWater concentrated on contracted products, such as deliverables, synthesis products should go beyond the deliverables and somehow wrap up NeWater research insights and products. The NeWater general assembly unanimously agreed on a list of twelve synthesis products (see section V):

Regarding WP 6.3, progress was good and the partners involved in this activity (USF and Wageningen University) gained very positive feedback on the whole from participants of the various summer schools and training courses we organised. We are particularly pleased with the fact that we were able to include participants from so many countries, not just European countries but those further afield (more than 30 countries were represented in our courses). In doing so, besides meeting the objectives 16 and 17, WP 6.3 also supported the achievement of objectives 14 (to deliver a comprehensive methodology and protocol for its use that demonstrates best practice in using innovative tools for adaptive management drawn from the NeWater case studies) and objective 15 (to develop an innovative toolkit and guidance for practitioners in applying methods for the adaptive water management of river basins).

The work package team feels that it has fulfilled the objectives of its programme in terms of reaching out to future water practitioners and researchers in order to enhance their knowledge and skills in making the transition to more adaptive and integrative approaches to water management. In addition, a chapter of the book on the theme of teaching adaptive water management was submitted for publication. The chapter has been accepted with minor changes and will appear in 2009: Catharien Terwisscha van Scheltinga, Caroline van Bers and Matt Hare. Chapter 5: Learning systems for adaptive water management: experiences with opencourseware. In: UNU-UNESCO Capacity Development in the Water Sector.

IV.6.3 Major achievements

After four years of NeWater, WB 6 can lay claim to having made a number of achievements in project coordination and management. Coordinating and managing a **transdisciplinary project** with **38 partners from 15 countries** with very different backgrounds is certainly challenging. In general, WB 6 achieved successful **scientific and administrative coordination** between the consortium partners. A specific achievement of WP 6.1 was internal exchange, which took place in various forms by establishing a structured communication and scientific exchange using face-to-face meetings, structured work block and work package coordination via the extranet tool, as well as online meetings and phone conferences. Productive cooperation was particularly achieved by establishing a **Project Internal Coordination Platform** (PICP) and maintaining cooperation and exchange via regular PICP meetings and General Assemblies. Four General Assemblies for the whole project consortium were organised in Mallorca (2005), Hortobagy (2006), Egypt (early 2008) and Seville (late 2008), as well as various PICP meetings. The meetings proved to be enormously useful for the scientific exchange of the various work packages, the development of further project steps, processing dissemination activities and decision-making on the issues of project administration. Moreover, the general assemblies offered various interactive opportunities for internal knowledge exchange, e.g. via internal workshops and a marketplace.

One main achievement in WP 6.2 was the project's visibility at all major water conferences over the past four years (Stockholm Water Week (every year), World Water Forum 2006 & 2009, International Water Associations, European Water Conference 2009). Moreover, WP 6.2 strongly supported the accessibility of the project results through a website, newsletters, policy briefs, flyers and brochures, especially supporting the basin activities in the state of finalisation with translated material.

The main project-related event was the **first International Conference on Adaptive and Integrated Water Management** (**CAIWA**), which was held in Basel from 12 - 15 November 2007. Several international organisations and the European Commission supported the conference. Roundtables at the CAIWA-Science-Policy Day moreover gave members of the scientific community, water managers and policy makers the opportunity to hold intensive discussions. In addition to a book[1] with triple-blind reviewed contributions from the NeWater project, most partners took the opportunity to present their results at the conference and receive external feedback on the content of their work. The organisation of the CAIWA conference, with high international visibility, encouraged cross-cutting working groups within NeWater to wrap up research insights and to discuss them with a broader audience.

A further major step regarding the progress of results was the successful development and implementation of the **synthesis process**. The synthesis process aimed at reflecting and embracing central NeWater outputs. Each of the twelve synthesis products addressed specific target groups, such as EU-level water policymakers, water basin authorities, local authorities, NGOs and the academic community. The synthesis products were presented at the final NeWater conference in November 2008, amongst other places, and are now available online.

WP 6.3 offers three main results. The first one refers to the implementation of summer schools and training courses, including three summer schools and three training courses, involving participants from almost 30 countries and multiple disciplines. The training events were very successful in developing conceptual understanding through lectures, discussion and practical exercises. The second main result is the implementation and public launch of online teaching curriculum in adaptive river basin management (www.NeWatereducation.nl). The curriculum provides lecture material, discussion questions and exercises/assignments that instructors can incorporate into their existing teaching

[1] Pahl-Wostl, C., Kabat, P. and J. Möltgen (2008) Adaptive and Integrated Water Management. Coping with Complexity and Uncertainty. Berlin / Heidelberg / New York, Springer.

curricula or for the development of new teaching programmes. Finally, an accompanying train-the-trainer course for teaching AWM has been given twice and will be held at least once more in May 2009.This course is aimed at (current and future) academic instructors who wish to incorporate AWM into their teaching programmes. It provides them with an intensive training course in the foundations of AWM, an introduction to the online curriculum, approaches to teaching AWM and an exercise in using the online curriculum to devise their own teaching course.

IV.6.4 Main messages

From the perspective of the project coordination and management under WP 6.1, smaller projects with fewer partners would have been more feasible to conduct successful work in European research. The coordination and management tasks of large projects such as NeWater are very time-consuming, due to both the ambition and size of the project and the complex bureaucracy of European projects. Often, the tasks exceeded the capacity of the funding for the project. The latter was a particular problem for partners from developing countries. More flexibility in terms of the European Commission's regulations and administrative freedom would certainly help the management to deal more effectively with the projects. Nevertheless, the strong investment of capacities in coordinating the consortium and giving them support in administrative issues certainly paid off in the end. The stability of the consortium and the cooperative and constructive working atmosphere among partners demonstrated this as much as the various results of the project. Moreover, projects with a focus on active research in particular also have to be considered as a social process, where the time requirements for communication and exchange among researchers and between researchers and stakeholders cannot be overestimated. NeWater succeeded in building up a high capacity in the context of adaptive water management under uncertainties, much of which might remain unused after the comparably short project duration of four years. In order to deliver profound results from all of the research areas and particularly from the active work with stakeholders in the case studies, support and funding for follow-up activities are essential. This does not inevitably imply the initiation of a NeWater II project. Our recommendation would be rather to establish and financially support smaller projects on adaptive water management in the context of a changing environment, where consortium partners as well as stakeholders can build upon their experience gained in the NeWater project. A further very interesting task that could not be met within the capacities of the NeWater project would be a profound analysis and scientific evaluation of the management procedure and the communication structures of large transdisciplinary research projects, such as NeWater.

When the project started, NeWater was one of the first projects to promote Adaptive Water Resources Management to water policy makers. Under WP 6.2, the project made a significant contribution to the present awareness of approaching uncertainties in RBM. However, the impact of policy science activities also requires the commitment of European (water) policy makers, including presence at project conferences, and openness for discussion and exchange. The need for the dissemination of results in the basin also requires the translation of the main results. NeWater took this into consideration, and had the central brochure and final project flyer translated. These translations complement the efforts of the case study partners in the basins to provide vernacular material. Targeting policy-makers and water managers, short and concise material such as the newsletter, policy briefs or the brochure generated the most interest. Additional reports, such as originally planned in the reporting series, did not gain very interest and often put a further strain on partners trying to complete work on the obligatory deliverables.

The main message of WP 6.3 is that the importance of the type of training provided cannot be overestimated. The work package team was repeatedly asked if it could hold more summer schools on the theme of AWM as well as courses on teaching AWM, particularly by people from developing countries. We are exploring ways (including various collaborations with other water-related institutions) to continue these training activities. In addition, the online curriculum is of course intended to be a form of dissemination of educational materials on AWM. The team also intends to put

the teaching materials on CD-ROM for those who have limited internet access, especially in developing countries.

IV.6.5 Outlook

Many of the consortium partners are currently still busy with preparing and following up activities to disseminate the project results in the form of books, journal publications and conference presentations, or in the form of PhD theses and new research projects. Many of the activities, especially in the case study basins, are being continued or implemented into national or regional projects or further research activities. Examples include the following projects and activities:

- Twin2Go (Coordinating Twinning Partnerships towards more Adaptive Governance in River Basins)
- PSI-connect (Policy Science Interactions: Connecting Science and Policy through Innovative Knowledge Brokering)
- SCENES-Project on Water Scenarios for Europe and Neighbouring States (Tisza basin)
- G3C-Network on Global Climate Change Collaborative Climate Water (Bridging the Gap between Adaptation Strategies of Climate Change Impacts and European Water Policies)
- Determination of Resource Quality Objectives and Service of the South African Water Act (Orange basin)
- HIGHNOON (Prioritization of Adaptation Options in Water Management)

The most important outlook for future dissemination activities (WP 6.2) is that many of the synthesis products are taken up by the partners in follow-up activities (see 6.1). The combination of supporting synthesis and providing external communication is central to the visibility of the research results. Follow-up projects should take this into consideration by devoting special resources and efforts to it, as in the NeWater project.
Regarding an outlook for WP 6.3, the team's experience suggests that training is a central element of the transition to adaptive and integrated water management, and more efforts should be invested in this activity. Dissemination activities should be ongoing, as the 'market' for this product is extensive. Partners are preparing a strategy for maintaining and upgrading the curriculum and accompanying capacity development activities.

V Where to find out more about NeWater and Adaptive Water Management?

All public NeWater products **are available on the project webpage: www.NeWater.info or www.NeWater.uos.de**
Central themes of AWM have been addressed in **Policy Briefs**, enabling water policy makers to gain a first impression of AWM & Uncertainty, Climate Change and Poverty & Gender Issues. **12 Synthesis Products** give special emphasis to cross-cutting themes in NeWater:

No.	Synthesis Product	Description
1	Management and Transition Framework	Facilitates analyses of water management processes, social learning and water regimes.
2	Uncertainty Guidelines	Provides insights on how different types of uncertainty can be approached in adaptive management processes.
3	Tailoring NeWater Insights to EU Policy Processes	Addresses "burning policy issues" related to uncertainty, stakeholder participation and global (climate) change.
4	Climate Change Adaptation Book	Provides insights into various adaptation strategies for climate change.
5	Water Resources Scenarios for CS Regions	Evaluates water resources scenarios for the case study regions taking into account recent climate predictions.
6	Cross-Comparison of Climate Change Adaptation Strategies across Regions	Compares the awareness of climate change and adaptation strategies in several regions.
7	Process for Analysing Dynamic Vulnerability and Adaptive Capacity	Describes a process for analysing dynamic vulnerability and adaptive capacity.
8	Special Feature on Implementing Participatory Water Management: Recent Advances in Theory, Practice and Evaluation	Presents participatory approaches for research and management.
9	Guidebook	Explains experiences, outcomes and benefits of the transition to Adaptive Water Management.
10	AWM Section	Facilitates knowledge transfer for resources related to Adaptive Water Management (http://wise-rtd.info)
11	Training and Guidance Material	Helps to build capacity among those who "train" water managers.
12	Online Curriculum	Provides academic instructors with teaching materials on Adaptive Water Management (www.newatereducation.nl)

Linking up with the community of **IWRM,** NeWater cooperated with the Global Water Partnership and presents selected results and case studies on the **GWP Toolbox (www.gwptoolbox.org)**.

VI List of PhD theses written in the NeWater project

Institute of Environmental Systems Research, University Osnabrück - USF:

Herrfahrt-Pähle, E. (in preparation): Transition towards adaptive and integrated water governance regimes in the context of climate change.

Isendahl, N. (in preparation): (Re-)framing Uncertainties in Water Management Practice, PhD Thesis to be handed in by August 2009.

Huntjens, P. (in preparation): Adaptive Water Management in a Changing Climate. Submission planned for August 2009.

Stuart-Hill, S. (in preparation): Mainstreaming Climate Variability and Climate Change into Policy and Decision Processes for Adaptation in Water Resource Management in two South African catchments. Submission planned for May 2011.

Int. Centre for Integrative Studies, University Maastricht - ICIS-UM:

Van Raak, R. (in preparation): Multiscale Transition Governance, PhD dissertation, will be finalised mid 2010.

Institute of Hydrodynamics, Academy of Sciences - IHAS:

Sona Nemeckova (in preparation): Simulation of hydrological processes and quantities using SWIM model in small and meso-scale river basin in comparison to measured data; will be finalised until December 2010.

Max Planck Institute for Meteorology, University Hamburg – MPI-M:

Starke, E. (in preparation): Changes in droughts and heat waves in Europe under changing climates, status: interrupted due to sick leave and maternity leave.

Potsdam Institute for Climate Impact Research - PIK (in cooperation with Humboldt University Berlin):

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