NeWater

THE RELATIONSHIP BETWEEN IWRM AND ADAPTIVE MANAGEMENT

Discussion input for NeWater international platforms

NeWater Working Paper 3

NeWater project -
New Approaches to Adaptive Water Management under Uncertainty

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Purpose	This document has been written to inform the discussions on the relationship between IWRM and Adaptive Water Management in the NeWater international platforms. The goal is to develop a joint view on the expected contributions of the NeWater project to improving the conceptual foundations and the practical implementation of the IWRM principle.
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1 Background

On several occasions the question has been raised as to what is the difference between IWRM and Adaptive Management and do we risk confusing water managers by introducing a new concept? This paper attempts to answer this question by clarifying the relationship between IWRM and Adaptive Management of water resources. The paper starts with a summary of the tradition of water management and introduces IWRM as one response to overcome shortcomings of traditional water management regimes. Adaptive management is introduced as a concept that may complement missing elements of current approaches to IWRM. Expected contributions of the NeWater project are highlighted as means to improve the conceptual foundations and the practical implementation of the IWRM principle.

2 Tradition of Water Management

In the past, water resources management was characterized by well-defined problems that society wanted to be solved. The hygienic problems within cities drove major efforts in urban water management. Eutrophication problems in lakes and coastal seas triggered research and legislation. Rivers were controlled to protect cities from flooding. Technological fixes proved to be very efficient in solving a number of these urgent environmental problems, e.g. wastewater treatment and the increasing sophistication of wastewater treatment plants addressing hygienic and pollution problems. In general these problems were dealt with in isolation and potentially, undesirable long-term consequences were not taken into consideration. The human dimension was taken into account as an "external" boundary condition. The system paradigm on which traditional water management was based can be characterized as a "command and control" approach. However, new, more integrated approaches have been developed and are currently implemented to address these shortcomings. IWRM is a clear step forward in this direction.

3 IWRM and Integrated Resources Management in general

Integrated environmental resources management may be defined as a purposeful activity with the goal to maintain and improve the state of an environmental resource affected by human activities. "Integrated" clearly indicates that resources management should be approached from a broad perspective, taking all potential trade-offs and different scales in space and time into account. However, implementation of integrated resources management that fully accounts for the complexity of human-technology-environment systems has yet to be realized. The increasing awareness of the complexity of environmental problems and of human-technology-environment systems has encouraged the development of new management approaches based on the insight that the systems to be managed are complex adaptive systems (Pahl-Wostl, 2002; Pahl-Wostl in press; Prato, A. (2003),Light and Blann 2000, Committee on Grand Canyon Monitoring and Research (1999)). Complex adaptive systems are characterized by being composed of many interacting components and emergent properties that cannot be predicted by knowing the components alone. Control is distributed rather than central.

Two major areas of knowledge gaps are identified that may impede the successful implementation of such new management approaches:

- *A rigorous conceptual foundation*: New management approaches should be based on a sound understanding of what determines a system's resilience, vulnerability and adaptive capacity. How can one characterize water management regimes (accounting for both their components and their interdependence) and analyze their performance (reaching management objectives, ability of the management regime to adapt to change etc) under current and future drivers? This work demands concepts that

simply and elegantly convey the key elements of this complexity when we prioritise research, discuss policy and interpret the results of monitoring.

- *Clearly defined trajectories of adaptation*: Current water management regimes have evolved over decades, and change is slow. How can we directly study and analyse transition processes when the scale of change approaches or exceeds the time horizon of academic projects or careers? Such a sound understanding of the transition processes and barriers for change is essential to the implementation of a stepwise transition process towards integrated and adaptive resource and water management regimes.

It is argued that IWRM can only be successfully implemented if more attention is given to understand and fill these knowledge gaps. Such improvements may also provide arguments to counter the increasing number of critical voices.

Recently various authors argued that the IWRM approach, as it is defined by the GWP, cannot be implemented in practice generally due to operational questions and related problems of establishing measurable criteria (eg. Jeffrey and Gearey, in press, Kluge 2005; Lankford and Cour 2005; Biwas, 2004).

Biswas (2004) and a couple of respondents to his article pointed out several barriers to implementation. Integration of sectors and issues would require more centralized policy development and implementation and thus larger, slower, and more bureaucratic authorities to handle all policy aspects. Furthermore, objectives like stakeholder participation and decentralization would be unlikely to promote integration. Biswas (2004) even stated that the GWP approach is un-implementable, internally inconsistent, based only on trendy words, and does not provide any guidance for water professionals as to how the concept could be used to make planning and decision-making more efficient. While Biswas is correct in criticising the vagueness of the IRWM concept, it should be noted that he regards only the operational (what will be) side of the concept. In summary the following main limitations of IWRM have been highlighted in these discussions:

- vagueness of the concept,
- integration of many topics and management of a system for a specific purpose cannot be realized simultaneously,
- the claims for change in management practice made by the promoters of IWRM seem to be based on normative claims rather than a sound scientific base that would provide evidence of these new management approaches,
- examples for the successful implementation of IWRM are lacking,
- emphasis on process without clearly defined and measurable targets for the goals to be achieved.

Let us investigate in more detail the current IWRM approach as promoted by the GWP to investigate if these arguments are justified and to determine needs for improvement and the potential contribution of adaptive management approaches.

The Global Water Partnership (GWP) defines IWRM as '*a process which promotes the co-ordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*.' (GWP-TEC, 2000) [1].

More recent information about the current state of the IWRM concept and its implementation as understood by the GWP can be found in the TEC Background paper No 10 (GWP-TEC,

[1] GWP-TEC (Global Water Partnership - Technical Advisory Committee), 2000, Integrated Water Resources Management. TAC Background Papers No. 4. (GWP, Stockholm, Sweden)

2004)2. The report, attempts to describe the "Why, What and How" of the IWRM planning processes based on the current state-of-the-art to provide guidance for countries who struggle with implementing IWRM to fulfil the goals for sustainable water management as declared during the last world summit on sustainable development in Johannesburg, 1992.

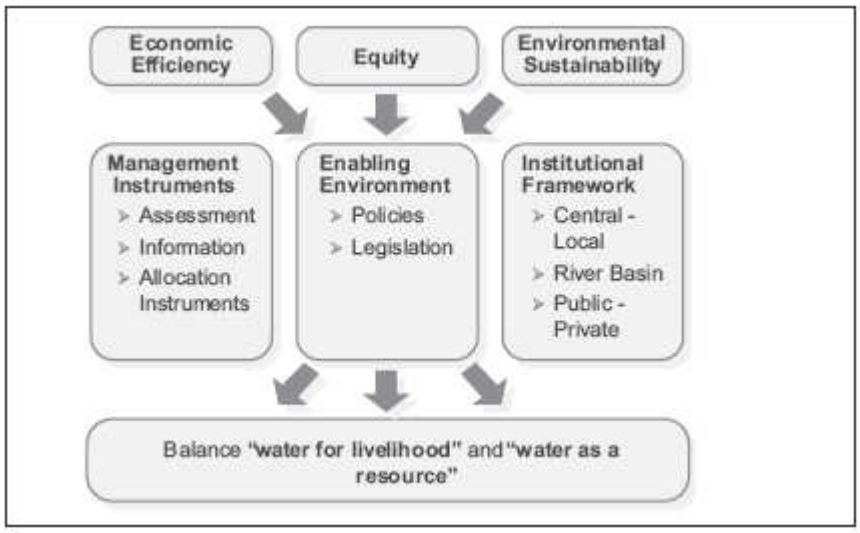

Figure 1. The "three pillars" of Integrated Water Resources Management: Enabling Environments, Institutional Framework and Management Instruments (adapted from TEC No 10, Figure 1).

Figure 1 shows the three pillars of IWRM: management instruments, enabling environment and institutional framework. Environmental, social, and economic goals influence these three pillars, which are perceived to be essential to achieve the balance between human and environmental well being. What is noteworthy is the emphasis on societal factors which have often been neglected in water management in the past

Figure 2 summarizes the steps in the IWRM cycle and how they can be performed (extract from TEC No 10).

[2] GWP-TEC (Global Water Partnership - Technical Advisory Committee), 2004, Integrated Water Resources Management (IWRM) and Water Efficiency Plans by 2005. Why, What and How? TEC Background Papers No. 10. (GWP, Stockholm, Sweden)

The Integrated Water Resources Management Cycle

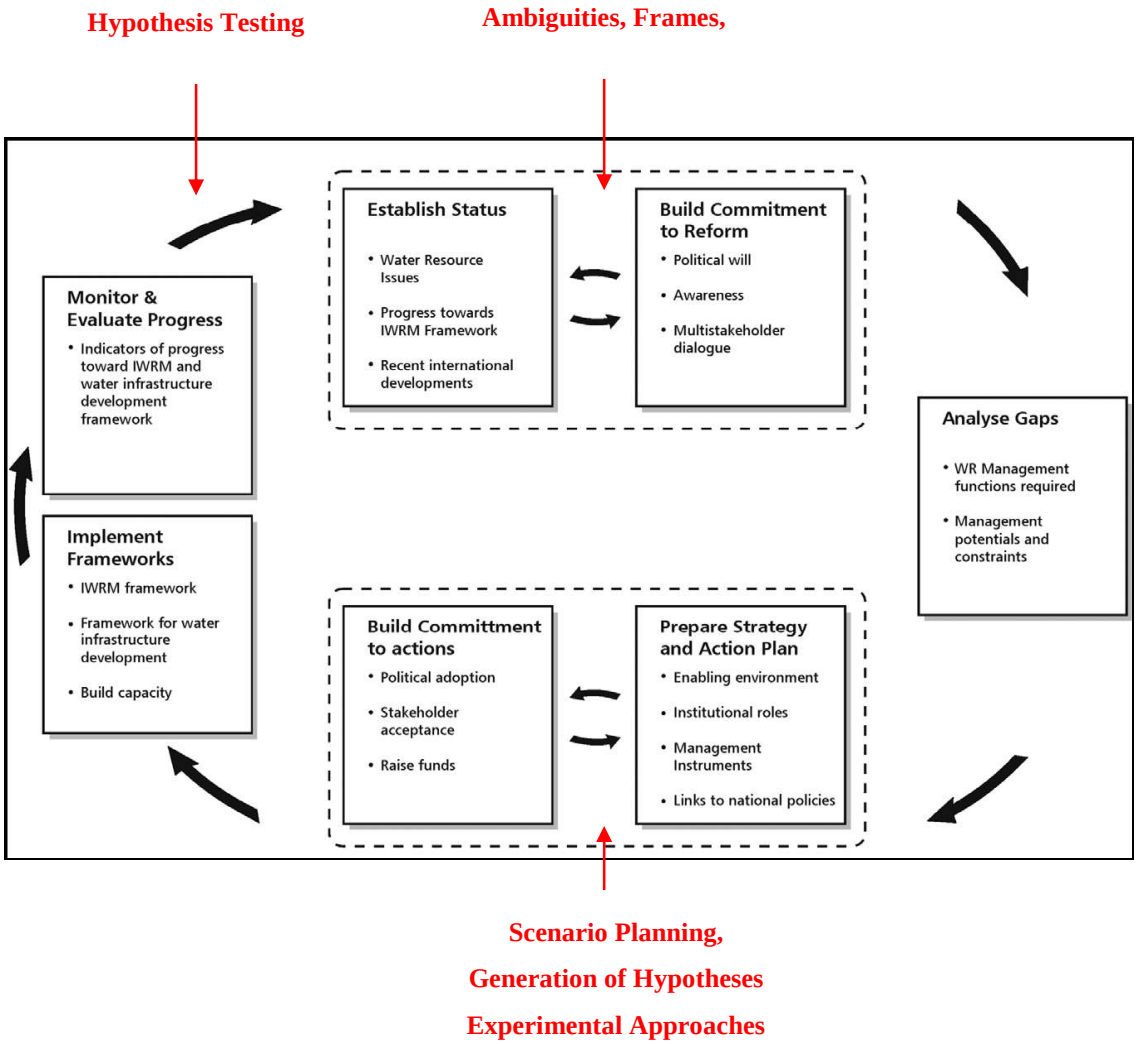

Figure 2. Different steps in the IWRM cycle (from TEC No 10, Figure 3 there) with considerations of what would be needed to take into account uncertainties and make water management more adaptive .

Table 1. More detailed explanations of the different steps in the IWRM cycle (from TEC No 10) shown in Figure 2.

Establish Status and Overall Goals. The starting point of the IWRM process is the burning and urgent water resources issue seen in the national context. Chart the progress towards a management framework within which issues can be addressed and agreed on and overall goals be achieved. Do international agreements with the neighbours present potentials/constraints? Pragmatism is key.
Build Commitment to Reform Process. The political will is a prerequisite and building or consolidating a multi-stakeholder dialogue comes high on the list of priority actions. The dialogue needs to be based on knowledge about the subject matter and awareness raising is one of the tools to establish this knowledge and the participation of the broader population.
Analyse Gaps. Given the present policy and legislation, the institutional situation, the capabilities and the overall goals, gaps in the IWRM framework can be analysed in the light of the management functions required by the urgent issues.
Prepare Strategy and Action Plan The strategy and action plan will map the road towards completion of the framework for water resources management and development and related infrastructural measures. A portfolio of actions will be among the outputs, which will be set in the perspective of other national and international planning processes.
Build Commitment to Actions. Adoption of the action plan at highest political levels is key to any progress and full stakeholder acceptance is essential for implementation. Committing finance is another prerequisite for taking planned actions to implementation on the ground.
Implement Frameworks. Transforming plans into reality poses huge challenges. The enabling environment, the institutional roles and the management instruments have to be implemented. Changes have to be made in present structures and building of capacity and capability also taking into account infrastructure development need to take place.
Monitor and Evaluate Progress. Progress monitoring and evaluation of the process inputs and outcomes serve to adjust the course of action and motivate those driving the processes. Choosing proper descriptive indicators is essential to the value of the monitoring.

As pointed out in Table 1, the GWP follows a pragmatic approach informed by political constraints and stakeholder needs. It is also evident that the implementation of the goals of IWRM requires a major change in current management practices and water governance regimes. IWRM can thus be characterized as a politically pragmatic approach to overcome the short-comings of current water management regimes to provide urgently needed innovation. The emphasis has been on practical applications. Hence it is not too astonishing that the scientific basis of the IWRM concept is not yet very well developed. This situation is unlikely to change given those practitioners who remain sceptical that science, and theory in particular, offer little of practical use. It can further be noted that how to deal with uncertainties is not explicitly addressed in current IWRM approaches. The TAC Background paper No 10, for example, does not include one single time the words uncertainty or scenario. This is quite astonishing given the fact that in the introduction of the GWP IWRM toolbox it is stated that: “The global economy and society are dynamic and the natural environment is also subject to change, IWRM systems will, therefore, need to be responsive to change and be capable of adapting to new economic, social and environmental conditions and to changing human values.” Another TAC Background paper No 7 on water governance advocates clearly the need for governance systems to be more flexible and to take uncertainty into account. We agree that flexible governance systems and management strategies taking into account different kinds of uncertainties are urgently needed since:

- Ambiguity exists in defining operational targets for the different management goals to be achieved and conflicts of interests require participatory goal setting (not by experts only) and a clear recognition of uncertainties in this process.

- Outcomes of management measures are uncertain due to the complexity of the system to be managed and due to uncertainties in environmental and socio-economic developments influencing the performance of implemented management strategies.
- New knowledge about system behaviour may suggest options for change in management strategies.
- Changes in environmental and/or in socio-economic conditions may demand change in management strategies.

Overall, we identify a clear need for a more coherent and comprehensive approach based on sound conceptual foundations to deal with uncertainties in IWRM. It is possible that the previous IWRM "practical" emphasis on policy deliberation at the expense of conceptual development (science) robbed it of the tools to simply describe and address the challenges of uncertainty. We propose "Adaptive water management" to improve the conceptual and methodological base to realize the goals of IWRM in an uncertain and complex world.

One may distinguish different types of uncertainty that need to be taken into account (Pahl-Wostl, et al, 1998, Funtowicz and Ravetz, 1990; Walker et al, 2003; Oberkampf, et al, 2001):

- The best-known type is lack of knowledge due to limited availability and variability in data. Quite a few technical approaches exist to include such uncertainties in simulation models. Uncertainties may be captured by including uncertainty bounds in results from model simulations or other types of quantitative assessments.
- An equally important but less often acknowledged type of uncertainty is uncertainty in system understanding, not only historic trends but the system elements and their interactions (feedback loops and delays) that generate those trends. This applies in particular to socio-economic systems and human behaviour where more than one possible interpretation exists for the same phenomenon. But also the understanding of ecosystems is not as far developed as that of hydrological systems, the home turf of many scientists and practitioners working in water management. IWRM requires understanding human-environment-technology-systems in their full complexity!
- Another source of uncertainty inherent in system behaviour rather than in the knowledge about it is the inherent unpredictability of certain factors. One prominent example is climate change and corresponding changes in nature and the likelihood of extreme events. To cite one example among many, animal evolution in response to climate change is already documented, but the full consequences for ecosystems or society is hardly known. Uncertainty may also arise from the diversity of institutions and underlying mental models that constrain stakeholder perceptions and actions. Stakeholders may hold different perceptions and use the same type of information to construct quite different meanings of what is at stake: the goals to be achieved, likelihood of the success of measure etc. The simultaneous presence of multiple frames of reference to understand a certain phenomenon is also called ambiguity (Dewulf et al, in press).
- Finally one should not neglect uncertainty in the implementation of regulatory frameworks (Newig et al, in press). Such frameworks may prescribe an operational implementation of policy goals such as "the good ecological status" required by the WFD but be derailed or sabotaged by a varieties of failures to learn, to cooperate or to implement policies on the part of different groups (Sterman 2000, Vennix 1996).

In the face of these challenges, ignorance and/or negligence represent more of a non-approach to deal with uncertainty in water management. Management needs first to broaden public debate and understanding of such uncertainties and the consequences of failure to address them.

Numerous technical and quantitative approaches already exist to include uncertainties in the analysis and policy formulation. Qualitative uncertainty can be tackled in a variety of

participatory approaches targeted at achieving learning processes and negotiations with agreements despite different perspectives.

But as pointed out before, to take into account all uncertainties in a more comprehensive fashion, a change in the overall management approach is needed. Adaptive management embeds uncertainty as fundamental principle in the management approach (Gunderson, Holling and Light 1995). Adaptive management will enhance the intellectual paradigm of IWRM to reduce its current ambiguity. Part of the current implementation of IWRM is clearly moving towards an adaptive management style and NeWater research will support this promising trend.

4 Adaptive Water Management

Adaptive management can more generally be defined as a systematic process for continually improving management policies and practices by learning from the outcomes of implemented management strategies (Pahl-Wost et al, in review). The most effective form of adaptive management employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed. In the approach promoted in NeWater, adaptive management has yet another target: to *increase the adaptive capacity of the (water) system*.

"Adaptive management is learning to manage by managing to learn" where learning encompasses a wide range of processes that span the ecological, economic and socio-political domains in the testing of hard and soft approaches (Gleick 2003). In this respect adaptive management emphasizes as IWRM the importance of the process nature of management without claiming that the process is an end in itself but by explicitly recognizing that management strategies and even goals may have to be adapted during the process.

NeWater is based on the hypothesis that IWRM cannot be realized unless current water management regimes undergo a transition towards more adaptive water management.

The hypothesis needs to be critically tested and current arguments supported by more in-depth scientific analyses. This requires developing a sound conceptual base to characterize what makes a water management regime adaptive, why and under which conditions adaptive regimes should perform better, and how a transition towards more adaptive water management regimes can be achieved and the goals of IWRM be realized.

4.1 The history of the adaptive management concept and implications for IWRM

The idea of adaptive management has been discussed in ecosystem management for quite some time (Holling, 1978; Walters, 1986; Pahl-Wostl, 1995: Lee, 1999). It is based on the insight that the ability to predict future key drivers influencing an ecosystem, as well as system behaviour and responses, is inherently limited. Hence management must be adaptive and include the ability to change management practices based on new insights. Adaptive management refers thus to a systematic process for continually improving management policies and practices by learning from the outcomes of implemented management strategies. The most effective form of adaptive management employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed (e.g. Gunderson, 1999; Kiker et al, 2003: Richter et al, 2003). This implies that hypotheses can be generated and that the outcomes of experiments allow one to distinguish the comparative advantages of different hypotheses.

Adaptive management includes at its core an assessment cycle. Close inspection of an AEAM (Adaptive Environmental Assessment and Management) learning cycle (Figure 3A) shows that it can be portrayed as a recasting of the scientific method of hypothesis testing, coupled interactively with modelling (Figure 3B), such that it is fully integrated with formulation of policy and implementation (management) of action plans based on policy. The early pioneers and principal drivers of the development of AEAM were modellers, such as Carl Walters. Policy was an important goal, but not an end goal. Policy within the scientific context is seen more as an expression of how to test the best hypotheses or questions generated during assessment. Getting stuck with a policy, even one that started as a good policy, strangles innovation and understanding in a changing world. Therefore, striving to answer good questions (inquiry) is as important as implementing good policy (management). The latter should be part of the former, and visa versa. That should be a key scientific pivot around which the learning process revolves.

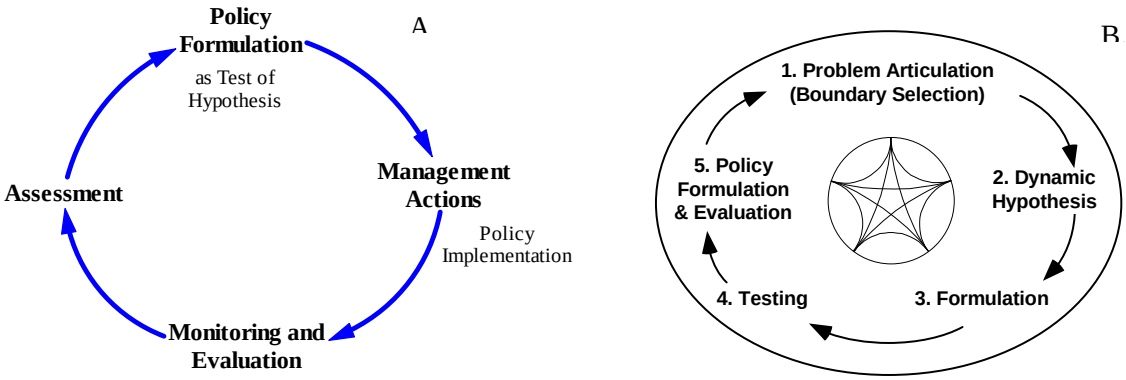

Figure 3: A) - Adaptive management process as a structured learning cycle that iteratively links four phases: starting from assessment, through policy formulation to implementation, and monitoring used as an input for the assessment phase in the next cycle (after Magnuszewski et al. 2005); B) – Iterative process of model development (steps1 – 4) linked to policy formulation whose evaluation stimulates re-assessment of the problem (after Sterman 2000).

However, integrating learning with changes of policy is only possible if the policies implemented can be changed. The transition to adaptive management relies on *increasing the adaptive capacity of the (water) system* by meshing management (policy) with learning. It aims at integrated system design based on an understanding of the interdependence between technologies, economic factors, formal and informal institutional context. The problem to be tackled is to increase the ability of the whole system to respond to change rather than reacting to undesirable impacts of change. Institutionalising this learning capability over the long term will secure the adaptive foundation of management.

What are now the requirements for adaptive management in river basins:

(1) New information must be available and/or consciously collected (e.g. indicators of performance of management regimes, indicators for change that may lead to

desirable or undesirable effects) and monitored over appropriate time scales (longer than those mandated by short-term political objectives).

(2) The actors in the management system must be able to process this information and draw meaningful conclusions from it. This can be best achieved if the learning process unites actors in all phases of assessment, policy implementation and monitoring. If the information collected answers the questions (hypotheses) they posed, then the science and the management are transparent to all involved.

(3) Change must be possible in ways that are open and understandable to all actors. Management must have the ability to implement change based on processing new information in a learning process where it is clear as to who decides how and when to change management practices, based on which evidence and why.

Any management regime has to be judged based on the above listed requirements.

Some structural requirements for a system to be adaptive have been tentatively summarized in the following table. Two different regimes are arbitrarily contrasted as the extreme, opposing ends of 5 axes in the following table derived from Pahl-Wostl et al. *in review*. Any regime typology rejects the idea of an infinite variety of approaches and is based on the assumption that management regimes can be clearly classified into different groups based on some internal logic of cohering characteristics.

	Prevailing Regime	**Integrated, Adaptive Regime**
Governance	Centralized, hierarchical, narrow stakeholder participation	Polycentric, horizontal, broad stakeholder participation
Sectoral Integration	Sectors separately analysed resulting in policy conflicts and emergent chronic problems	Cross-sectoral analysis identifies emergent problems and integrates policy implementation
Scale of Analysis and Operation	Transboundary problems emerge when river sub-basins are the exclusive scale of analysis and management	Transboundary issues addressed by multiple scales of analysis and management
Information Management	Understanding fragmented by gaps and lack of integration of information sources that are proprietary	Comprehensive understanding achieved by open, shared information sources that fill gaps and facilitate integration
Infrastructure	Massive, centralized infrastructure, single sources of design, power delivery	Appropriate scale, decentralized, diverse sources of design, power delivery
Finances and Risk	Financial resources concentrated in structural protection (sunk costs)	Financial resources diversified using a broad set of private and public financial instruments

Sectoral integration and polycentric governance have been claimed by IWRM supporters for quite some time. NeWater will develop indicators to analyse if and why certain attributes of a regime make management more adaptive and if and why a more adaptive management regime supports the achievement of the goals of an integrated and sustainable water management as promoted by IWRM.

Example to illustrate an adaptive management approach for environmental flows

Obviously an IWRM approach would not address environmental flows in isolation from all other water related issues. While it will in any case be addressed from this wider perspective, for educational purposes it useful to focus on this example which too often is under-appreciated.

Management goal: Achieve and sustain a good ecological state of a riverine ecosystem.

Allocation problem: Environmental flows have to meet certain minimal criteria regarding the total amount of water available of appropriate quality for ecosystem water needs and the spatio-temporal variability of these flows.

Allocation of water to environmental water needs may be in conflict with other water needs for irrigation in agriculture (mainly seasonal variability and absolute amounts), hydropower generation (seasonal and diurnal variability), storage for water use (absolute and seasonal variability). Knowledge about the implications of the spatio-temporal variability of water flows on ecosystem function and ecosystem services is limited. Whereas it may still be possible to quantify individual factors (minimal flow requirements) it is very difficult to predict implications of a change in different factors occurring simultaneously (e.g. minimum flow requirements, water availability during critical period of a year, diurnal variability) since these factors typically influence different ecosystem processes that are themselves interdependent.

What would it mean if one adopts adaptive management into the IWRM approach to tackle this problem? These changes are indicated in Figure 2 as follows:

- In the definition of goals different perspectives are taken into account. Specific tools are used to analyse ambiguities and mental frames that may hinder agreement on a common goal or a desired future state that should be achieved. The emphasis on pragmatism would be complemented by an emphasis on a sound stakeholder and institutional analysis, which should be the base for the design of any further stakeholder dialogue. At the same time a sound knowledge base on environmental and socio-economic factors should be developed.
- Scenario development to analyse the range of possible changes in climate and/or socio-economic developments and other factors that influence sectoral water demand and regional water availability. Any strategy and action plan has to be evaluated within the context of future scenarios within which it will unfold.
- Participatory and model-supported development and analysis of different management options and appropriate implementation of small-scale experiments that allow increase in knowledge of the response of socio-ecological systems. The strategy and action plan should include hypotheses on the possible outcome of management interventions. To implement adaptive management regimes it may be required to implement far reaching changes to increase the adaptive capacity of the governance regime which may include changes in the role of actors, power relationships, formal and informal institutional setting (e.g. change in water rights).. Such changes will normally go in parallel with the implementation of new management approaches.
- Evaluation of the robustness of different management strategies under different scenarios, which include the need to change management strategies (e.g. allocation quota to different users) based on new insights. One may wish to choose robust strategies that perform reasonably well under a number of different scenarios and that may allow to change strategies if needed rather than optimal strategies that perform optimal under one possible future scenario or pragmatic strategies that can be agreed upon by the majority of stakeholders.
- Design of monitoring programmes and monitoring panels that allow one to critically reflect on the success of implemented strategies, test, refute and/or reformulate hypotheses that were the basis of those strategies and that try to detect potential undesirable developments at an early stage.
- Implementation of a an integrated research-policy process that is transparent as to who decides, based on which evidence, why to change a management practice.

4.2 Expected results of NeWater with high relevance to IWRM and how to communicate the goals of the NeWater project to stakeholders?

Both IWRM and Adaptive Management have developed as concepts and methods on their own. They have different origins. Whereas IWRM has always been strongly linked to the engineering community, AM has been closely linked to ecosystem science. Both struggle with the challenge to include the human dimension.

Regarding the work in the basins it should be made clear that the experience generated by both approaches can inform the development of the other. Including insights from adaptive management aim at an enhancement of IWRM rather than replacing it as a concept.

Consequences should be communicated by examples from management problems rather than explanation of concepts.

NeWater will encourage the enhancement of IWRM by developing:

- an innovative "cookbook" with connected toolkit and guidance for practitioners in applying methods for the adaptive management of river basins.
- an understanding of aspects that determine adaptive capacity and vulnerability of river basins
- a comprehensive methodology to develop, implement and decide between alternative management regimes that are tailored to the institutional, cultural, economic and environmental characteristics of a basin.

To achieve its objectives NeWater research is designed as a highly interactive and dynamic process. NeWater does not prescribe an integrative framework such as a DSS or integrated model which would constrain the type of knowledge that can be integrated. NeWater aims at the joint design of an interactive, integrated and open knowledge base. As such NeWater is also a novel experiment in how to conduct interdisciplinary research which is carefully monitored and analysed to draw lessons for similar projects in the future. We anticipate that insights and methods developed in NeWater will be tested for years in IWRM and AM implementation projects.

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