INTEGRATED SCENARIOS - THE KEY FOR SUCCESSFUL WATER AND RIVER BASIN MANAGEMENT?

Gooch, Geoffrey D.*, Stålnacke, Per**

Department of Management and Economics, Linköping University, SE-58183 Linköping, Sweden
(E-mail: geogo@eki.liu.se)
*** Jordforsk- Norwegian Centre for Soil and Environmental Research, F.A. Dahls vei 20, N-1432 Ås, Norway*
(E-mail: per.stalnacke@jordforsk.no)

ABSTRACT
In this paper, the ways in which an integrated river basin management approach for the new EU border have been developed will be discussed. The approach has evolved in an on-going applied research project, MANTRA-East, in which thirteen research groups from six countries cooperate. As water and river basin management demands a combination of information produced by different scientific disciplines, a particular goal of the project has been to develop methods to integrate results from three different scientific standpoints. These are (i) a natural science perspective, involving studies of nutrient loads and its impact on ecology (ii) an information perspective, involving studies of ways to improve the communication of environmental information, and (iii) a policy science perspective, involving studies of policy instruments, economic factors, and public participation. In this paper we analyse the problems inherent in inter-disciplinary research into water and river basin management, and the ways in which the MANTRA-East project has attempted to solve these problems. It is proposed that a viable approach for integrated water management involves the creation of a framework of alternative river basin management scenarios that combine inputs from the various scientific disciplines. Scenarios also appear to be an attractive methodology to increase stake-holder and end-user participation, as they may facilitate an integrated discussion about river basin and water management.

KEYWORDS: Interdisciplinary research, Integration, River basin management, Scenarios

INTRODUCTION
Policy-makers and water managers have traditionally regarded water quality issues as mainly originating in one specific cause, and they have often taken the view that there is usually one straightforward solution to the pollution problem. Today, however, it is generally accepted that water-related problems are far more complex and problematic, and that simple cause and effect approaches are insufficient. It is now realised that abatement strategies must adopt a different approach, in which problems originating in different spheres are seen as interdependent. For example, local pollution problems may be interrelated with environmental change and socio-economic development to such an extent that a single disciplinary or sectoral approach can no longer provide a satisfactory solution. Another example is that water quality issues related to surface waters are now being correlated to both hydrological characteristics and terrestrial biogeochemical processes, including land use change and other basin-wide anthropogenic issues. Another aspect of this problem is the conflict between social and economic development on the one side, and environmental and pollution concerns on the other. Water policy analysts have therefore increasingly come to recognise that managing waters can no longer be regarded as an independent field of expertise and a separate domain of public policy. It is now accepted that the interconnections between water systems, other aspects of environmental systems, and human systems, are extremely important areas of study. Thus, it has become apparent that water and river basin management should be based on an integrated approach, involving planners, scientists, policymakers, end users, and the public. Even though integrated water resource management, integrated water management and integrated river basin management are currently practised in many regions worldwide, we still have not been able to 'solve' pollution and water management problems, and examples of 'success stories' are difficult to find. In the case of the new EU member states, the EU Water Framework Directive (WFD) will become a central tool for the future environmental water management and legislation of their river basins. However, while the EU's environmental *acquis* and management doctrines will be adopted by the succession states, several studies have recognised that the environmental problems being faced in the succession states are far more severe than in the present Member States. Thus, there is a need for truly integrated and functioning basin-wide cooperative schemes for water management. Integrated river basin management is also central in the EU Water framework Directive, and the implementation of this new principle requires comprehensive interdisciplinary analyses (Schultz 2001). In this respect, the experiences gained in the on-going research project MANTRA-East 'Integrated strategies for the management of transboundary waters on the Eastern European fringe – the pilot study of Lake Peipsi and its drainage basin' may prove to be valuable. The project was initiated to facilitate the search for integrative strategies and integrative examples. The pilot study was Lake Peipsi, the largest international lake in Europe. The lake is shared by one EU-accession state (Estonia) and one non-EU state (Russia), and thus of high relevance for the future environmental management of transboundary waters on the new EU border region.

INTEGRATION! INTEGRATION?
Integration is the buzzword of today in water and river basin management, often used to demonstrate that the research being conducted is up-to-date and to distance the results from traditional conceptualisations. The term is however commonly used without further and deeper consideration. Far from being an accepted and easily understood notion around

which there is consensus, the entire concept and exact definition of integrated water management (IWM), integrated water resource management (IWRM) and integrated river basin management (IRBM) is widely debated, and ambiguous, and a unanimously agreed definition of the concepts has yet to appear. The Technical Advisory Committee of Global Water Partnership has however adopted the following definition:

> "IWRM is 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."

Key points here are *process, coordinated,* and the relationship between *sustainability* and *economic and social welfare.* The definition does not, however, give us much indication of how this coordination (and integration) is to be achieved. IWRM, as well as IWM and IRBM, constitute five main characteristics that may cause complications and problems (Mostert 1998). Multifunctionality (e.g., fishing, farming, water supply), user interests and conflicts, multiple managers at different levels (e.g., local, regional, national), asymmetric power-relations (e.g., up- and downstream users and managers), and technical complexity. The distinction between "integrated" and "traditional" management of water, river basins or water resources to a large extent relies on the scope and sphere of operation of the two. Whereas the latter is typically sector-oriented (water supply, irrigation, hydropower, etc.) and focused on satisfying the perceived demands within each sector, the former attempts to take a cross-sectoral approach and focus as much on management of the water or in terms of water resource management on the demand, supply, and use of water. In order to develop the distinction between traditional and integrated approaches, it is useful to examine the forms of concept polarities that can exist, and their possible forms of integration. The following table presents a selection of these; more could of course be added.

Table 1. Examples of polarities and examples of forms of integration

Polarities	Examples of Forms of Integration
Economy versus Ecology	Environmental economics
Sector versus sector	Environmental planning and cooperation between economical sectors
Nation versus Nation	Transboundary river basin management
National authority versus Municipality	Multi-level government
Government versus Non-governmental organisations	Governance
Policy makers versus Stake-holders/the public	'Bottom-up' policy-making
Scientists versus Policy/decision makers	Scientific communication strategies
Land versus Water	Land use change/nutrient loss models
Surface waters/groundwater *vs.* Coastal waters	Coastal zone management
Water quantity versus Water quality	Water boards
Upstream versus Downstream users	River basin management
Large scale versus Small scale approaches	Regional perspective
Water supply versus Wastewater management	'Grey water' and use of wastewater for irrigation
Social scientists versus Natural scientists	Multidisciplinary and/or Interdisciplinary approaches

This short overview demonstrates that *integration* can have multiple meanings and that the interpretation of the concept depends to a certain extent on the perceptions of what it is that should really be integrated. While all of these polarities present considerable problems, it is perhaps within the final distinction, that between social scientists *versus* natural scientists, that the most difficult obstacles become apparent. Despite efforts by a number of institutes to develop interdisciplinary research into water and environmental issues (for example at the universities of East Anglia in the UK and Linköping in Sweden) the results can often be characterised as more multidisciplinary than interdisciplinary. The problem is to develop a cross disciplinary dialogue while at the same time retaining the distinctive scientific depth of the individual disciplines. In the following section we will examine the epistemological differences between the disciplines involved in water management, and attempt to identify the main barriers to constructive interdisciplinary research.

SCIENTIFIC DISCIPLINARY DIFFERENCES

There are a number of central questions that each scientific discipline would probably answer in a different way. According to Losee (1980) these issues are (i) which characteristics distinguish scientific inquiry in this discipline from other forms of investigation, (ii) what procedures should scientists in this discipline follow, (iii) what conditions must be satisfied for the explanation to be correct, and (iv) what is the cognitive status of scientific laws and principles? The debate is of course ancient, and in order to clarify the modern controversy on the best ways to analyse and improve water management we need to begin with the foundations of the debate, and with the ideas of the classical Greeks. Plato's idealism provides radically different answers to the question of knowledge than Aristotle's inductive/deductive empirical methodology. While Plato's philosophical approach dominated in Europe prior to 1150, the translation of Aristotle's writings on science and scientific method during the 12^{th} and early 13^{th} centuries provided scholars with new insights. The scientific debate diverged and by the early 19^{th} century the central issues were inductivism versus the hypotheticodeductive method.(Losee 1980). While the traditional mechanical view of nature was sometimes questioned, the view that dominated was ‘scientific materialism’, one that *‘presupposes the ultimate became the ultimate fact of an irreducible brute matter, or material, spread through space in a flux of configurations…senseless, valueless, purposeless’* (Whitehead 1926, p.22). Although some philosophers of science such as Kuhn state that science is not a steady, cumulative acquisition of knowledge, but instead a series of interludes punctuated by intellectually violent revolutions (Kuhn 1970), positivist philosophy now dominates the natural sciences, a philosophy based on casual laws of phenomena, derived from observation (Outhwaite 1987). In the social sciences, however, the central issues are the debate on the importance of *structure* versus *agency*, on *meaning*, and on the *construction of social reality.* Winch, for example, stresses the importance for the study of human actions of *meaningful behaviour*, and states that *‘ the analysis of meaningful behaviour must allot a central role to the notion of a rule’* (Winch 1958, p.51). The concept of *rules*, in the form of informal institutions such as norms and values, is now a central issue for the social sciences. The differing traditions of the natural and social sciences express themselves in a number of ways. One important aspect in the case of transboundary water management is the diffe rent attitudes to the question of open or closed systems. While natural scientists, taking an empirical, positivist point of departure, are aware of the impossibility of a closed system outside of the laboratory (an even within it now that quantum physics has been accepted), they are often willing, for the purpose of prediction, to adopt an approach that postulates just such a closed system. Social scientists, on the other hand, usually believe that *‘because social systems are intrinsically open and cannot be artificially closed, our criteria for the empirical testing of social theories cannot be predictive and so must be exclusively explanatory’* (Bhaskar 1989, p.5). Within water management we can therefore identify a number of significant epistemological differences between the scientific disciplines involved. The nature of the system (closed or open) being studied is one. Another is the nature of the object of study, of whether it consists of *brute matter* or *meaningful behaviour.* A third is the difference between the procedures (quantitative/qualitative, inductive/deductive etc.) considered correct for scientists to follow when conducting scientific enquiry. However, social scientist is in general characterised by heterogeneity, and some social science disciplines may find it more easy than others to cooperate with natural scientists. David Braybrooke has identified three sides of social science (Braybrooke 1987). These are the ‘naturalistic’ (positivistic) view, the ‘interpretive’ view, and the ‘critical’ view. The ‘naturalistic’ approach selects problems, and utilises methods, that have much in common with those predominant in the natural sciences. Proponents of this school seek casual regularities and prediction. According to the ‘interpretive’ view, the methods used by the natural sciences (and by the ‘naturalist’ approach) are not applicable to the study of social phenomena. *Rules* and *meaning* are important concepts for this approach. Finally, the ‘critical’ approach looks for underlying power relations, and seeks to explicate the interests of the actors and structures. Social scientists working within these schools tend to identify different problems, and to study them with different methods, and some will find it easier than others to work with natural scientists.

When it comes to IWRM, IWM or IRBM the natural science perspective focuses on the different fundamental processes (biogeochemical)in river basins and water systems. Thus the natural science perspective can potentially contribute to basic information, e.g. in river basin management plans. One main limitation is that natural scientists focus on the object, the river basin itself, and less on the management process (Mostert, 1999). In addition, the national or international character of river basins is often not important (Marty, 1997). Social scientists, on the other hand, and especially disciplines working with policy and decision-making, have their starting point in the social sphere and not the river basin (Mostert, 1999). Thus the social science perspective may contribute to the understanding of the structure, ideas and strategies of actors and the 'management' of the decision making process (Klijn, 1979). In contrast to natural science, social science approaches can also apply equally to national and international river basins, and especially to the differences in management at various administrative levels, as well as concerted management of transboundary river basins, and harmonisation of IRBM policies (Mostert, 1998). One main limitation with the social science perspective is that IWRM and IRBM are not only about actors and scales but also about the river basin, and especially the interaction between actors and river basins (Mostert, 1999). It is therefore necessary that various perspectives on IWRM and IRBM must be combined. As experience has shown, this is however far from straight-forward. The ways in which the MANTRA-East project has attempted to overcome the problems inherent in interdisciplinary research are described in the next section.

THE MANTRA-EAST APPROACH

The MANTRA-East project had three main objectives. The first of these was to evaluate the applicability of the EU Water Framework Directive in the future EU border regions. This includes an assessment of the state of eutrophication (*e.g.* ecological status) in lakes and river basins, as well as the development of strategic lake and river basin tools for source apportionment, retention, and time-trends in nutrient loads. The second objective was to develop methods to improve communication and utilisation of scientific information. The third objective was to develop institutional mechanisms and policy instruments for decision making under conditions of transition and uncertainty. The first objective was primarily the domain of the natural scientists in the project, the second objective was mostly managed by geographers and information specialists, and the third objective was the responsibility of the social scientists and policy analysts. The underlying rationale behind this model was that scientific information produced by the natural scientists was needed in the policy process, as well as knowledge of the policy process (decision-making and implementation) itself. This information needed to be communicated to the actors in the policy process, as well as to stakeholders and end users. The problem facing the project leaders was that each objective was based on, and produced, different forms of knowledge, or, to put it in another way, each objective was dependent on a different scientific paradigm (Kuhn 1970). While respecting the different disciplinary approaches and methods, it was necessary to find a way to integrate the knowledge produced, and to create a fertile cross-pollination of ideas, concepts, and hypotheses. The natural science approach was based on quantitative methods and the results that could be analysed through statistical methods and mathematic models. The communication of scientific knowledge was studied through a combination of information cycle methodology and qualitative analyses of communicative processes. The policy process, the involvement of stakeholders, and public participation were analysed using a heuristic approach in which qualitative interviews, surveys, focus groups, text analysis and institutional analysis were combined. The experience of the project team was that understanding of each others epistemological viewpoints could, and was, increased by continuous discussions of the nature of the problems and the best ways to solve them. In this way the project adopted a problem-based methodology, attempting to elucidate the central aspects of water management from various viewpoints. The difficulties with the approach were, after an initial period, minimised and resulted in an increased understanding of each others' scientific beliefs. The next step was to develop an approach that was synergetic, and which resulted in a greater understanding of the problems of water management than if each discipline had simply presented individual results which were then combined in a final report. The approach chosen was that of qualitative-quantitative-qualitative scenarios.

SCENARIOS

During recent years the use of scenarios for environmental policy-making has attracted considerable attention from both the scientific community and policy-makers (see, for example, (Greeuw, et al. 2000), and for business aspects (Ringland 2002)). Many of these applications have however either focussed on conditions in larger spatial scales, such as countries (Kahane 1997), or have utilised relatively well-known cases where information, while not comprehensive, has been comparatively readily available (Greeuw, et al. 2000). As regards conditions in transition and post-transition countries, scenarios have not yet been so widely used. Scenarios are not precise predictions of the future (Porter 1985), they should be seen as simulation tools, as a technique similar to, but different from, models (Jouvenel 2000). Scenarios attempt to construct general representations of possible alternative futures. Alcamo (2001) identifies five main elements of scenarios. These are a description of the changes that may take place; of the main factors and driving forces that influence these changes; a definition of the beginning year of the scenario, the base year; the selection of the time frame for the scenarios and the adoption of time steps; and the construction of the storylines, which are narrative descriptions of possible futures. Scenarios can be especially useful in environmental assessments as they can provide a picture of future alternative states of the environment, and this is an important aspect, as a major problem facing policy analysis is the need to manage and analyse vast amounts of information, a task that is often overwhelming (Hill 1997). Scenarios, through their simplification of this information, can make this process easier. Basically scenarios can be qualitative or quantitative, explorative or normative. In the MANTRA-East project, qualitative scenarios, 'storylines' or 'scripts', were first developed (Gooch 2003). These were narrative texts that were representations of possible futures. They did not contain detailed numerical information, and could be written in an easily understandable manner. Utilising past and present trends, the qualitative scenarios attempted to see which factors might lead to likely futures. The qualitative/explorative scenarios were then used as input into computer models that can best be described as quantitative/explorative in the first stage, and Quantitative/Normative in a second stage see (Mourad, et al. 2003). According to the project methodology, the results of the quantitative models will then later be used to modify the qualitative scenarios, and to develop qualitative/normative scenarios that will provide policy recommendations. This planned combination of storylines and set of model calculations is similar to that used in the 'World water vision scenarios – the world water situation in 2025' (Cosgrove and Rijsberman 2001). In the MANTRA-East qualitative scenarios, different levels of economic development and cooperation have been used as determinants. Three alternative future scenarios have complemented the traditional 'business-as-usual' scenario. However, as the study concerns a border region in which two countries with differing conditions interact, it has been necessary to construct two different groups of scenarios, one for each country. While these groups of scenarios have been based on similar driving forces, the results of these forces have differed according to the specific conditions in the countries. In order to construct regional scenarios, these country-specific scenarios have been combined. As the number of alternatives has been considered excessive, only a limited number of regional scenarios have been constructed. While the focus of the study has been on transboundary interaction at a regional or sub-regional level, sufficient material has not been available to allow the construction of qualitative scenarios at this geographical level. Instead, possible future trends at national and sub-national levels have been used to construct the regional and sub-regional scenarios. The time period that has been chosen is twelve years, from 2003 to 2015.

Seven factors were identified as central for the scenarios. These were Population, Agriculture, Fishing, Economy, Politics, Administration, and Environment. As in the IMAGE scenarios (Alcamo and Nakicenovic 1998), the primary driving forces included population and economic growth rates. As the span of factors is relatively large, it might be claimed that even at this stage the qualitative scenarios were integrated, and that they included economic, social, and environmental factors. However, the qualitative scenarios were not seen as an end in themselves. Instead, they were used as an input to computer-model based quantitative scenarios, thus creating an integrated process between a qualitative, social science based approach and a quantitative, natural science based approach. The European Environment Agency report *'Scenarios as tools for international environmental assessments'* (Alcamo 2001) proposes a 'story-and-simulation' (SAS) approach to developing scenarios. A variant of the SAS model has been used in this study, with the quantitative 'storyline' scenarios presented here constituting the first step of the process. As with the SAS model, the results of the quantitative modelling will be utilised as input into revised qualitative storylines.

CONCLUSIONS

To conclude, the specific approach used in the MANTRA-East project was based on the creation of alternative water management scenarios that combined input from the various scientific disciplines. The procedure included the following sequential steps:

1. The creation of mutual disciplinary respect and a basic understanding of all scientific approaches.
2. The definition of 3-4 qualitative story-line scenarios on regional development.
3. The translation of the qualitative story-line scenarios into quantitative GIS-layers.
4. The modelling of the nutrient fluxes and loads in the drainage basin.
5. The modelling of the transformation of nutrient in the lake and the ecological consequences.
6. Analyses of the policy and socio-economic implications of the modelling results, including an analysis of the value of scenarios from an information perspective.

Our experiences have demonstrated that an approach can be developed that respects the integrity of individual scientific disciplines while at the same time combining and integrating approaches so that synergic results are obtained. The first basic step is to create a working atmosphere that combines mutual respect with scientific questioning, that is, representatives of the different disciplines must learn enough of each others approaches to be able to dispute both the methodology used and the results obtained. While this critical questioning will by necessity be restricted to a non-expert level, it is still important that research team members do not simply accept other disciplinary paradigms at face value. The use of scenarios has enabled MANTRA-East participants to build upon the knowledge and results of both natural and social science approaches, and to combine these in a reflective and alternate exchange in which qualitative and quantitative methodologies are combined.

REFERENCES:

Alcamo, J. (2001). Scenarios as tools for international environmental assessments. Copenhagen, European Environment Agency**:** 31.

Alcamo, J. and N. Nakicenovic (1998). "Long-term greenhouse gas emission scenarios and their driving forces." Mitigation and Adoption Strategies for Global Change **3**(2-4): 343-381.

Bhaskar, R. (1989). Reclaiming Reality. London, Verso.

Braybrooke, D. (1987). Philosophy of Social Science, Prentice-Hall.

Cosgrove, W. J. and F. Rijsberman (2001). The making of the world water vision exercise. World water scenarios. F. Rijsberman. London, Earthscan.

Gooch, G. D. (2003). Scenarios for Environmental Policy-Making on the Estonian-Russian Border. Linköping, Department of Management and Economics, Linköpings University**:** 17.

Greeuw, S. C. H., M. B. A. v. Asselt, et al. (2000). Cloudy crystal balls. Copenhagen, European Environment Agency.

Hill, M. (1997). The Policy Process in the Modern State. London, Prentice Hall.

Jouvenel, H. d. (2000). "A Brief Methodolgical Guide to Scenario Building." Technological Forecasting and Social Change(65): 37-48.

Kahane, A. (1997). Imagining South Africa's Future. Learning from the Future. L. Fahey and R. M. Randall, Wiley.

Klijn, E. H. and J. F. M. Koppenjan (1997). "Beleidsnetwerken als theoretische benadering: een tus-senbalans." Beleidsnetwerken **2**: 143-167.

Kuhn, T. S. (1970). The Structure of Scientific Revolutions. Chicago, The Unversity of Chicago Press.

Losee, J. (1980). A Historical Introduction to the Philosophy of Science. Oxford, Oxford University Press.

Marty, F. (1997). International river management - The political determinants of succcess and failure: Introduction and research design. Zürich, Universität Zürich.

Mostert, E. (1998). "River basin management in the European Union; How it is done and how it should be done." European Water Management: 26-35.

Mostert, E. (1999). "Perspectives on river basin management." Physics and Chemistry of the Earth Part B: Hydrology, Oceans and Atmosphere **24**: 563-569.

Mourad, D. S. J., M. V. d. Perk, et al. (2003). GIS-based quantification of future nutrient loads into Lake Peipsi / Chudskoe using qualitative regional development scenarios. The 7th International Conference on Diffuse Pollution and Basin Management, Dublin.

Outhwaite, W. (1987). New Philosophies of Social Science. New York, St. Martin's Press.

Porter, M. (1985). Competitive Advantage. New York, Free Press.

Ringland, G. (2002). Scenarios in Public Policy. Chichester, John Wiley & Sons.

Schultz, G. A. (2001). Integrated water resources management: the requirements of the European Union, the problems of environmental impact assessment, and implementation of the sustainable development principle. Integrated Water Resources Management. M. A. Marino and S. P. Simonovic, IAHS Publication no. 272**:** 3-12.

Whitehead, A. N. (1926). Science and the Modern World. Cambridge, Syndicate of the Press of the University of Cambridge.

Winch, P. (1958). The Idea of Social Science, Routledge.