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THE ROLE AND USE OF INFORMATION IN TRANSBOUNDARY WATER MANAGEMENT

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Finally, I would like to send a thought to my friends and family. The time with you outside work, I have to confess, is just the best.

Susanna Nilsson

Stockholm, April 2003

ABSTRACT

Management of water bodies according to their river basins is becoming increasingly common, as the concept of Integrated Water Resources Management (IWRM) is getting more and more acknowledged. In Europe, a large portion of these "new" management units will probably be international or transboundary. Decisions and policies considering transboundary water issues need to be based on reliable and comprehendible information. In this thesis, a review of various existing models that may be used for understanding the role and use of information in (transboundary) water management is presented. Further, the thesis reports on an assessment of the information management of three transboundary water regimes in Europe, namely the international water commissions for Lake Neusiedl, Lake Constance and Elbe River. Besides examining the information management of the regimes as such, the management was also related to information needs implied by the IWRM concept and by the EU Water Framework Directive (WFD). The reviewed models and approaches were grouped into three categories: information management models, information cycle models and communication between actors. The first category comprised models that may be used for managing and assessing different types of information. The second group dealt with models explaining the production and communication of information predominately from an information producer/sender perspective. The third group focused on ideas concerning interactions and communication of information between different kinds of actors. The studies on information management in transboundary water regimes showed that the information needs and strategies often were defined primarily with water commissions' own needs in mind. The data collected by the commissions were predominated by monitoring data, describing the status of the environment and the impact caused by human activities. Furthermore, any communication of information to other groups of actors was mainly done through passive channels. The information management in these transboundary water regimes was not fully in accordance with information needs implied by the IWRM concept and the EU WFD.

Keywords: Integrated Water Resources Management (IWRM); transboundary water management; information; EU Water Framework Directive (WFD); regimes; policy and decision making; Lake Neusiedl; Lake Constance; Elbe River.

TABLE OF CONTENTS

LIST OF PAPERS

This thesis is based on three papers that will be referred to in the text by their Roman numerals:

I. Nilsson, S. and Langaas, S., (2003) Understanding the Role and Use of Information in Integrated Water Resources Management: A Review of Selected Models. (In manuscript)

II. Nilsson, S. and Langaas, S., (2003) A comparative study of information management in three transboundary water regimes in Europe. Accepted for publication in: Timmerman, J.G. and Langaas, S., (eds.), *Environmental information in European transboundary river basin management*. IWA publishing, London, U.K. (In prep.)

III. Nilsson, S. and Langaas, S., (2003) Information needs and the EU Water Framework Directive: an assessment of the transboundary Lake Constance regime. *Water Policy*. (Submitted December 2002)

ACRONYMS AND ABBREVIATIONS

ACF	Advocacy Coalition Framework
CEU	Central European University
DPSIR	Driving forces-Pressures-Status-Impacts-Responses framework
EEA	European Environment Agency
EU	European Union
EU WFD	European Union Water Framework Directive
GWP	Global Water Partnership
ICPE	International Commission for the Protection of the River Elbe
ICWE	International Conference on Water and the Environment
IGKB	International Commission for the Protection of Lake Constance
IWAC	International Water Assessment Centre
IWRM	Integrated Water Resources Management
MANTRA-East	Integrated Strategies for the *Man*agement of *Tra*nsboundary Waters on the *East*ern European fringe – the pilot study of Lake Peipsi and its drainage basin
NGO	Non Governmental Organisation
UNCED	United Nations Conference on Environment and Development
UN ECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme

1. BACKGROUND

Policy and decision making on water issues needs appropriate information. While this general statement is valid to nearly all types of water related problems, it might be of special importance for water resources shared by several countries. There are around 261 international river basins[1], covering almost half of the world's total land surface. Of these, 71 are found in Europe (Wolf et al. 1999). Within EU, the Water Framework Directive (WFD), adopted in 2000, requires member states to establish river-basin districts and manage waters according to river basins. Thus, many of the river-basin districts currently under definition will probably be transboundary[2]. This means that politicians, planners, scientists, stakeholders and other groups of actors, from numerous different countries are likely to in the near future reinforce and increase their collaborations concerning information related activities, such as information collection, analysis, storage and use, for joint river basins.

This thesis has two themes, namely water management and information. In a more narrow focus, the thesis mainly considers transboundary aspects of these two. Furthermore, the work is limited to addressing information-related issues of transboundary water management in Europe, especially in relation to the EU WFD.

1.1 What is water management?

During the last decades, there has been a continuous call for more integrated management of rivers, lakes and groundwater, interrelating different social, economical and environmental aspects of water issues (e.g., UN ECE 1996, Grigg 1998, GWP 2000). People often refer to the idea of an integrated approach of water management as "integrated water management", "integrated water resources management" or "integrated river basin management". Thus, today it is generally accepted that water management should be "integrated", but the exact implications of the word are still rather fuzzy.

Much of the ideas around integrated management emerged from the Dublin principles, agreed at the International Conference on Water and the Environment (ICWE) in Dublin 1992 and the Agenda 21 chapter 18 on freshwater resources, adopted at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro 1992. The four Dublin principles state, in short, that fresh water is a finite resource, that management should be participatory, that women play a central role, and that water has an economic value in all its uses. In chapter 18 of Agenda 21, integrated water resources development and management is one of seven focus areas proposed for the freshwater sector. The ideas from these guiding policy documents are visible in what might be the most widely used and accepted definition of the concept Integrated Water Resources Management (IWRM). The Global Water Partnership (GWP) (2000) defines IWRM as:

> *a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*

Table 1 summarises main aspects to acknowledge in IWRM. As can be seen, IWRM requires consideration to a wide array of aspects. There are three overall criteria to respect: en-

[1] Wolf et al. define a river basin as "the area which contributes hydrologically to a first order stream, which, in turn, is defined by its outlet to the ocean or to a terminal lake or inland sea". Such a basin is defined as international "if any perennial tributary crosses the political boundaries of two or more nations".

[2] In this thesis, a water resource is regarded as transboundary if two or more countries share its basin. Thus, the word transboundary may in this thesis be used interchangeably with the word international.

vironmental and ecological sustainability, equity, and economic efficiency in water use. Apart from the overall criteria, there are natural system aspects and human system aspects that need to be considered.

By acknowledging IWRM as representing the most appropriate water management approach of today, it is implicitly evident that water quality and quantity problems are not only physical issues, easily solved by engineering techniques. Instead, water problems are indeed social issues, tightly connected to, e.g., economy and politics. This recognition, in turn, sets the frames for understanding the role and use of information in IWRM.

1.2 What is the role and use of information in IWRM?

In Merriam-Webster's Collegiate Dictionary (2001) (published on-line), "information" is defined according to four groups. These four groups are then further dived into sub-groups or sub-definitions. The first two groups of definitions probably grasp some of the most common notions of information:

> **information** *(noun)* **1 :** the communication or reception of knowledge or intelligence; **2 a** (1) **:** knowledge obtained from investigation, study, or instruction (2) **:** intelligence, news (3) **:** facts, data

Similarly, in the same dictionary, the word "communication" also has a number of different definitions. Of the in total five groups of definitions, the first three probably reflect many peoples' perceptions about the word:

> **communication** *(noun)* **1 :** an act or instance of transmitting; **2 a :** information communicated **b :** a verbal or written message; **3 a :** a process by which information is exchanged between individuals through a common system of symbols, signs, or behaviour

From the definitions above, it is clear that dictionaries do not provide simple and clear-cut explanations of information and communication, and neither do researchers engaged in the issues. For example, Barr and Masser (1997) define (geographic) information in four different ways: as a resource, a commodity, an asset or an infrastructure. Furthermore, Meadows (2001) has in his book *Understanding Information* named the chapters: Data, Information, Classification, Storage, Retrieval, Communication, Knowledge, and Intelligence and wisdom. These terms reflect fairly well the broad range of issues that information and communication might encompass. As definitions of information and communication differ, it makes no sense here to adopt specific ones. However, it should be pointed out that "information management" in this thesis has been used as a summary term for all kinds of information related activities, such as data collection, analyses and storage, and information use (including communication).

Although information is not defined as such in this thesis, there is broadly speaking, one particular type of information to consider when examining the role and use of information in the context of IWRM, namely environmental information. But then, the question is what actually that is. One generally accepted definition of environmental information is found in the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, done in Aarhus, 1998:

> *any information in written, visual, aural, electronic or any other material form on:*
>
> *(a) The state of elements of the environment, such as air and atmosphere, water, soil, land, landscape*

Table 1. Some main aspects to consider in IWRM (building mainly upon GWP 2000).

Aspects of IWRM	Comment, explanation
Overall criteria	
- Environmental and ecological sustainability[a, b]	For sustainable IWRM integration both within and between the natural and human system is needed. The time dimension has to be considered so that the resource is sustained over time, also available for future generations.
- Equity[a]	Equity in IWRM encompasses the basic right for all people to have access to water of adequate quantity and quality.
- Economic efficiency in water use[a]	Water resources should be used in the most efficient way due to its increasing scarcity and vulnerable nature.
Natural system aspects	
- Freshwater and coastal water management[a]	Fresh water systems may strongly influence the state of coastal waters and therefore these two elements must be integrated.
- Surface water and groundwater management[a, b]	Many people rely on groundwater for their water supply. However, the use of agro-chemicals and pollution from diffuse sources threaten the groundwater quality, and thus, IWRM needs to consider linkages between surface water and groundwater.
- Quantity and quality of water[a, b]	For IWRM the quantity of water available is important, but it needs to be considered in connection to the quality of the water.
- Land and water management[a, c]	It is recognised that, e.g., land use changes influence the physical distribution and quality of water. As a mean for integrating land and water, basin level management is important.
- Upstream and downstream water related interests[a, c]	Factors such as land use changes and pollution loading upstream may cause problems, like flooding and degraded water quality downstream. Also, this element stresses the importance of basin level management.
- "Green" and "blue" water[a]	By "green water" is meant water used directly for biomass production and water "lost" in evapotranspiration, while "blue water" is the water of lakes, rivers and aquifers. Traditionally, water management has focused more on "blue water". By also considering "green water", increased water use efficiency can be obtained through, e.g., changes in the crops cultivated.
Human system aspects	
- Intersectoral approach[a] between the: water sector; economic sector; and social sector	In policy development there is a need for integrating water resource policy with economic and social policies. IWRM should include cross-sectoral exchange of information and co-ordination procedures.
- Economic value of water[a, c]	In IWRM the full economic value of water should be recognised and taken into account. This includes full cost of water provision, internalising external costs for water services, economic valuing of environmental services and removing of unsustainable subsides for, e.g., agriculture to be replaced by subsides to enable poor people access to water.
- Involvement of all stakeholders in the planning and decision process[a, c, d]	The involvement of all stakeholders is a key element in IWRM. Therefore fora and mechanisms must be developed to ensure participation. Information should be communicated to all decision-makers and the public.
- Decision making at the lowest level possible[a, b]	Subsidarity is essential for IWRM.
- Institutional legal framework[b]	An institutional legal framework is a prerequisite for a successful IWRM. This framework should set the rules regarding allocation, development and protection of the water resource. Further, it should define the roles of government and stakeholders at different levels of society.

Sources: a GWP 2000, b Savenije and van der Zaag 2000, c Hartje 2002, d Grigg 1998

and natural sites, biological diversity and its components, including genetically modified organisms, and the interaction among these elements;

(b) Factors, such as substances, energy, noise and radiation, and activities or measures, including administrative measures, environmental agreements, policies, legislation, plans and programmes, affecting or likely to affect the elements of the environment within the scope of subparagraph (a) above, and cost-benefit and other economic analyses and assumptions used in environmental decision-making;

(c) The state of human health and safety, conditions of human life, cultural sites and built structures, inasmuch as they are or may be affected by the state of the elements of the environment or, through these elements, by the factors, activities or measures referred to in subparagraph (b) above;

This definition is, indeed, quite broad in scope and it makes it therefore suitable to refer to when addressing the role and use of information in IWRM. With this broad definition, practically all information related to IWRM is in fact environmental, at least as long as the overall criteria concerning environmental and ecological sustainability plays a dominating role.

Having outlined the concept of IWRM and given examples of definitions of information, it is now possible to continue and depict some specific roles of information in IWRM. Three specifically information related point-of-views can be distinguished. First of all, IWRM requires different types of information, ranging from natural science data, such as phytoplankton concentrations in the water, to socio-economic information, such as statistics on population and traffic (Dinar 1998). Secondly, the different types of information need to be analysed and integrated so that policy and decision makers can get an understanding of how the whole system functions. Thus, there is a need for transforming scientific knowledge into understandable information for policy and decision making (Szaro et al. 1998). Thirdly, the participatory aspects of IWRM, involving stakeholders and the public in the management process, require information to be communicated between different actors at various levels of society (Roll et al. 2003).

1.3 What characterise transboundary water management and the role and use of information in such contexts?

Co-operation around transboundary waters is generally quite complicated. One potential source of conflict may be related to the generally large scale of the water system, which makes it hard to oversee effects of changes in the system. For instance, it is often difficult to predict the effects of land use changes upstream, influencing the system downstream by, e.g., causing changes in flood levels. Another problem may be that national interests in the water resources differ, resulting in states developing policies and plans contradicting of each other. Further, there are often gaps between policies, plans and practices. New policies that deal with the complexity of water resources management may be hard to implement, because existing institutions are not organised in accordance with the policy. If policies and plans still are implemented, they often face problems because the reality is not behaving the way the policy anticipated (Savenije and van der Zaag 2000). Lastly, factors related to differences in the organisations of water management and the decision-making cultures between countries may complicate the co-operation on transboundary water issues (Meijerink 1999).

Savenije and van der Zaag (2000) have suggested the use of a classical temple as a model for sharing of international rivers (Figue 1). In their model, IWRM is the foundation and sharing of water resources the roof of the temple. There are three pillars, one technical, one political and one institutional, representing the necessary elements for the sharing of international waters. The authors argue that there is first a need for politics to provide an enabling environment, so that technical co-

operation and proper institutions may later be established (Savenije and van der Zaag 2000).

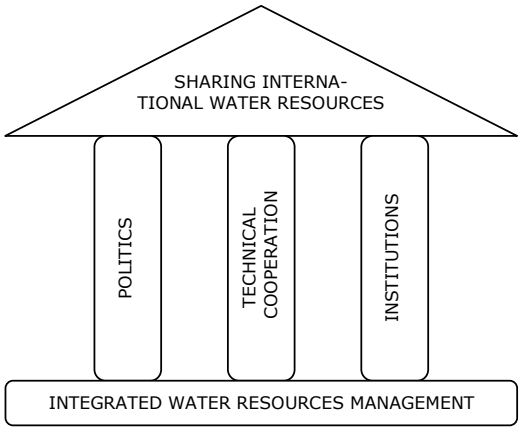

Figure 1. IWRM as a basis for the sharing of international water resources (from Savenije and van der Zaag 2000).

In practice, a common way for states to co-operate around transboundary waters is to establish river basin institutions, commonly referred to as international regimes. International regimes can be defined as:

> *sets of implicit or explicit principles, norms, rules, and decision-making procedures around which actors' expectations converge in a given area of international relations (Krasner 1983)*

However, the conception of international regimes is often narrower. Conca (1996) describes this narrower understanding as:

> *a specific form of international institution, in which states actively and consciously bend their behaviour toward the attainment of a collective purpose*

The formal co-operating body of a transboundary water regime, often a water commission, generally has many information related activities, such as monitoring of water quality and quantity, development of action programmes, standardisation of data collection and sharing of relevant data, among their most important functions (Enderlein 2001). Potential problems may arise if countries disagree on, e.g., the collection of data and exchange of information.

Furthermore, other actors, such as national and regional authorities, often responsible for the actual data collection and analyses, may have different norms, values and beliefs, resulting in opposite views on and traditions of information management (Gooch 2003).

1.4 Information and the EU Water Framework Directive

The EU WFD is a good example, showing that the ideas of IWRM now are starting to be introduced into laws, rules and regulations (Chave 2001, Fairley et al. 2002, Griffiths 2002, Holzwarth 2002). Some of the most integrated features of the directive have been described as management according to river basins; use of a combined approach to control pollution, by setting both emission limit values and water quality objectives; enforce the user to pay the true costs of providing and using water; and involve the public in decisions made around the resource (Chave 2001).

The directive is to be implemented by the 15 member states and 13 candidate countries; thus, shaping the water management in a majority of European countries. One of the first tasks in the implementation is to identify river basin management districts, which will become the new management units for surface waters, groundwater and coastal waters. As stated earlier, many of these districts will probably be transboundary.

It is probably not very controversial to assume that the WFD will affect the information management of actors, such as transboundary water commissions, involved in transboundary water issues. However, the degree of the influence is not fixed. Examining the directive from an information management point-of-view, there are two articles of special interest. These are article 13, concerning *River basin management plans*, and article 14, concerning

Public information and consultation. A river basin management plan should according to the directive include quite extensive information (Table 2). For example, a summary of an economic analysis of water use, a summary on pressures and impacts of human activity on the status of the water, and the state of surface water and groundwater should be included in the plan. Somewhat confusingly, article 13 specifies that member states *shall* co-operate for producing one single management plan for a transboundary river falling within the territories of the EU, but at the same time the directive indicates that if not produced, plans must be set up for the part of the basin falling within each state's territory. If the basin extends beyond the territories of the EU, the directive encourages member states to establish co-operation with non-member states and, thus, manage the water resource on a basin level. According to article 14, the active involvement of all interested parties for implementing the directive should be encouraged. This active involvement is mainly acknowledged in the production, review and updating of the river basin management plan. The directive itself is, however, not very specific on the forms of participation. Essentially, the article requires that a timetable, a work programme and planned measures for consultation should be presented for the public three years before the plan is to be enforced. Additionally, draft copies of the plan should be available for comments one year before the enforcement.

Table 2. Information of river basin management plans (article 13 and annex VII of the EU WFD) classified according to the DPSIR framework (described in 3.2) (modified from Lorenz 2003).

Category according to DPSIR framework	Information to be included in river basin management plans
D/P	- A summary of the economic analysis of water use
	- A summary of significant pressures and impacts of human activity on the status of surface water and groundwater
S	- State of surface water, ground water and protected areas
I	- State of protected water bodies used for drinking water supply
R	- Identification and mapping of protected areas
	- A list of the environmental objectives established under article 4 for surface waters, groundwaters and protected areas
	- A summary of the programme of measures
	- A register of programmes and management plans dealing with sub-basins, sectors, issues or water types
	- A summary of the measures taken for public information and consultation, their results and changes to the plan
	- A list of competent authorities
	- Contact points and procedures for obtaining background documentation and information

2. RESEARCH PROBLEMS AND OBJECTIVES

2.1 Research problems

Based on the background chapter, it is clear that the role and use of information in transboundary water management can be addressed from a wide array of perspectives. Quite many of the studies performed appear to be descriptive, for example, giving account of key aspects for successful water regimes or public participation (e.g., Vari and Kisgyorgy 1998, Botterweg and Rodda 1999, Cate 1999). However, an example of more experimental nature is a recent study, examining the use and valuing of environmental information in the decision-making and management of transboundary waters (Timmerman et al. 2003). Yet other more explorative or investigative studies have dealt with issues connected to the communication of information to stakeholders and the public in water management (e.g., Collentine et al. 2002, Roll et al. 2003).

Although there are many studies that, in a broad sense, deal with (transboundary) IWRM and information related issues, the numbers of studies focusing primarily upon the role and use of information are quite few. One reason for this might be the fact that information science and its cousin communication research are fields that cut across conventional academic disciplines. Instead of studying, for example, the social hierarchy among people, typically done by a sociologist, an information scientist would study how the hierarchy impedes or promotes the transfer of information. Thus, the information flow would be the red thread (Bates 1998).

2.2 Objectives

The overall objective of the thesis is to contribute to the understanding of the role and use of information in transboundary water management in Europe. This objective can be divided into the following:

- To identify and review models that can be used for understanding the role and use of information in IWRM (paper I)
- To provide knowledge on and examine differences and similarities of information management in three transboundary water regimes in Europe (paper II)
- To discuss and relate certain aspects of information management in transboundary water regimes in Europe against information needs implied by the IWRM concept and the EU WFD (paper II and III)

3. MODELS FOR UNDERSTANDING THE ROLE AND USE OF INFORMATION IN IWRM

3.1 Background

Finding material for a review of models for understanding the role and use of information in IWRM (paper I) may encompass a considerable survey of numerous databases, journals and websites. To restrict the study, literature mainly in the fields of environmental information/communication, environmental management and water management was considered. Library catalogues and bibliographic databases were searched for material. In addition, references in articles and books were used to find new sources of information. The intention was not to cover all available literature; instead, the study should be regarded as an attempt to make a brief overview of some relevant models. The models were arranged and analysed according to the following specific categories:

- Information management models
- Information cycle models
- Communication between actors

The arrangement of the models into these specific categories build strongly upon the author's pre-understanding of IWRM and information (described in 1.1 and 1.2). It is worth noting that there are no clear boundaries between the categories, but they are overlapping and so are the models presented.

3.2 Information management models

The models termed Information management models mainly focus upon management of different types of information. Generally, the models also address the connections between the different types of information, often in relation to possible information users. An example of such a model is the DPSIR (*D*riving forces, *P*ressures, *S*tatus, *I*mpacts, *R*esponses) framework, increasingly used for management and assessment of environmental information (e.g., UNEP/CEU 1997, Harremoës and Turner 2001, Lorenz et al. 2001, Timmerman et al. 2003). The framework assumes that there are interrelated links between social, economic and environmental systems (Figure 2). These links are illustrated conceptually by driving forces of environmental change, causing pressures on the environment, which in turn affects the status of the environment. The subsequent changes of the status are termed impacts and comprise impacts on ecosystems, economy, as well as population. The negative impacts will eventually lead to responses by society, such as the development of policies for river basin protection. If the policy has the intended effect, it will after its implementation influence the driving forces, pressures, status and impacts (EEA 1999). Another example of an information management model may be a framework presented by Burström (2000) (originally modified from Levett 1997), focusing on different techniques for information management.

Although the two presented approaches to some extent deal with the production and use of data and information, they do not explicitly describe the process of transforming collected data into information for policy and decision makers.

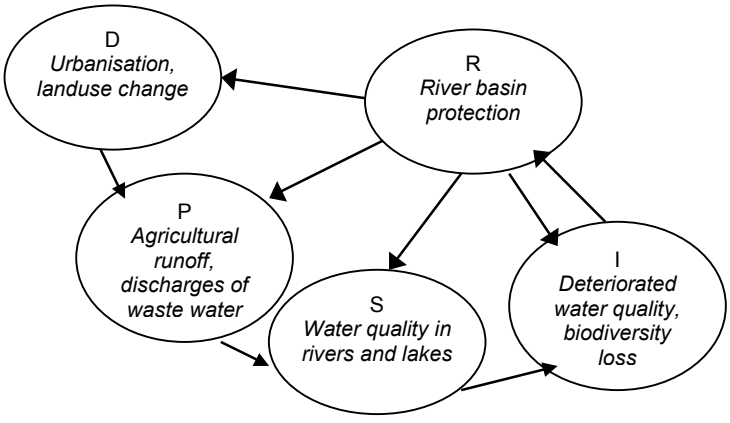

Figure 2. The DPSIR framework for management and assessment of environmental issues (from EEA 1999).

3.3 Information cycle models

In this section, models focusing primarily upon transformation of data into information for policy and decision makers are assembled. These models are also concerned about communicating the "right" information to information-users. An example of such a model is the Information cycle model (Timmerman et al. 2000). The Information cycle model was initially designed for optimising national water-quality monitoring (UN ECE 1996), but it has recently also been suggested to be used for facilitating water policy and decision making in general (Figure 3). The model describes the essential steps in the continuously on-going process of information production (and use). The cycle starts with defining information needs and strategies, followed by data collection and analysis, which finally leads to information utilisation for water policy and decision-making. The steps of defining information needs and strategies are regarded as the crucial ones for successful and effective information production (Timmerman et al. 2000). Based on experience, Timmerman et al. (2000) claim that effort must be placed on facilitating the dialogue between information producers, such as experts and scientists, and users, such as policy and decision makers, as the major problem in information production is that producers and users do not speak the same "language". Ideally, the two groups should be brought together, and then, in co-operation identify information needs and strategies. Another similar models may be a conceptual model presented by Sadler (1988) on the communication process, especially from an information sender perspective, for implementing awareness in societal planning and decision-making. Yet another variant may be the Impact-of-information-chain presented by Denisov and Christoffersen (2001), describing how communicated information may propagate in society, forming environmental friendly laws, investments and consumption patterns.

In common for the models described in this section is that they primarily focus upon the information producer or sender of information. The solution to communication problems can generally be overcome by tailor-making information, increasing communication skills among senders and choosing the "right" communication channels. Nevertheless, there are other models that concentrate more on different groups of actors and their interactions; thus, indirectly criticising the models with more rational views upon the information producer/sender and information user/receiver.

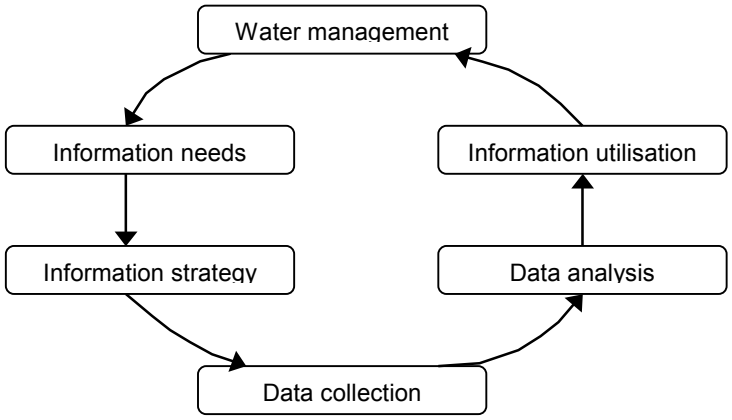

Figure 3. The Information cycle model (from Timmerman et al. 2000).

3.4 Communication between actors

In this third group, models concentrate on the communication between different actors involved in the management of water resources. Some of the approaches focus on a few key groups of actors and examine interactions between these groups in terms of communication and exchange of information. However, other approaches rather stress the whole actor network in itself as being the important factor.

Scientists, policy makers, stakeholders, the public, and – in the case of transboundary water management – states, are typically regarded as key actors in IWRM. The "science-policy gap" addresses the problem that scientists, supposed to provide information to policy makers, often are familiar with conditions of scientific uncertainty, while policy makers are not. The differences of scientific and government institutions, thus, give rise to the "science-policy gap"(Bradshaw and Borchers 2000). Concerning information for stakeholders and the public in IWRM, Roll et al. (2003) suggested and applied rational choice theories and cultural theories for studying the issue. As explained in 1.3, regimes are normally quite specific forms of international institutions where states meet and co-operate on specific issues. The formal co-operating body of a regime, often a water commission, often have many information-related tasks among their most important functions.

In a more network perspective, policy and decision making in water management occur within a system of multi-level governance, involving a range of different actors. Gooch (2003) argues that the different actors strongly influence and interact with each other and that the actors involved in the management can be regarded as members of an advocacy coalition, sharing the same belief system. Gooch (2003) proposes to study the institutional context of communication in (transboundary) water management, starting with identifying main gatekeepers. The role and position of these gatekeepers should then be analysed, and from there, suggestions may be made on how to improve communication (Gooch 2003).

4. METHODS AND MATERIALS

This chapter deals with the methods and approaches used in paper II and III. Although there are different actors involved in modifying and managing a water resource, and consequently also involved in the information related activities around the resource, the studies were restricted to only consider information management of formal transboundary water regimes. The primary motive for focusing on regimes was that they often are regarded as having a key role in transboundary water management (Delli Priscoli 2000).

4.1 Choice of frameworks

The Information cycle model and the DPSIR framework (described in 3.3 and 3.2 respectively) were used as a basis for analysing questions related to information management in transboundary water regimes (paper II and III). In general terms, the Information cycle model was used for understanding *how* information is managed, as the cycle describes the processes of information production (and use). The DPSIR framework, on the other hand, was used to address the question *what,* as the framework allows a grouping of different types of information into relevant and easy understandable categories.

The frameworks were also used to guide an assessment and discussion of information management in tranboundary water regimes today, in relation to information needs implied by the IWRM concept (paper II) and the EU WFD (paper III). The discussion related to IWRM was kept very general, while the discussion related to the EU WFD was more specific; focusing primarily upon information needs outlined in article 13 (river basin management plans) and article 14 (public information and consultation) of the directive (see 1.4).

4.2 Choice of methodology

The studies in this thesis rely heavily upon the use of qualitative methods. Social science, and qualitative research in particular, have often been criticised for being subjective and unscientific (Kvale 1997). This criticism has its roots in the views on science. One school of thought, commonly referred to as *positivism,* traditionally rejects qualitative research as science. According to a positivistic view, there is a value-free objective reality, in which objects and phenomena occur even without human knowledge about them. Scientific facts should be objective, quantified and the research arriving at the facts should be eliminated from human influence (Patel and Davidsson 1994). Thus, acknowledging this view makes it practically impossible to consider, for example, qualitative interviews as science. However, positivism has been criticised for not being able to keep to its own requirements on objectivity. Closer examination of the ways in which "objective facts" are reached, often reveal a range of theoretical assumptions, of inter-subjective character, built-in to the observation procedures. An opposite view to positivism is often referred to as *hermeneutics* or *relativism.* According to this school of thought, there is no such thing as objective reality; instead, all knowledge is subjective. Knowledge is gained through interpretation and understanding of the human reality. These interpretations are highly influenced by the environments, such as the society and the culture, in which they are perceived. Thus, the researcher is a part of the reality being studied (Kvale 1997).

In this thesis, environmental or water problems are seen mainly as subjective problems, to a large degree social constructions, shaped by peoples' perceptions about what a problem is. Thus, the studies in the thesis are not regarded as being completely without biases; instead, they are inevitably coloured by the investigator's views and perceptions. Consequently, there are no absolutely "true" answers to questions, such as what "the right level" of information for transboundary water management is. However, it should be emphasised that the acknowledged view does not imply that the author ignored aspects related to the scientific quality of the studies. On the contrary, the methods for data collection were carefully chosen and the validity, reliability and weaknesses of the studies were seriously dealt with (discussed in 4.5).

For examining information management in transboundary water regimes in Europe (paper II and III), case study methodology, in combination with elements of archival analysis approach were adopted as the main research strategies. According to Yin (1994), a case study is an empirical inquiry that:

- *Investigates a contemporary phenomenon within its real-life context, especially when*
- *The boundaries between phenomenon and context are not clearly evident*

Another typical characteristic for a case study is that it normally relies on multiple sources of evidence, quantitative, as well as qualitative (Yin 1994).

4.3 Selection of case study regions

Three case study regions in Europe were selected: Lake Neusiedl, Lake Constance and Elbe River (Table 3) (Figure 4). The author

did not participate in the selection of case regions. In fact, the selection was made already in year 2000, under the preparation of the application for the research project "Integrated Strategies for the Management of Transboundary Waters on the Eastern European Fringe – the Pilot Study of the Lake Peipsi basin" (MANTRA-East). In total, eight case study regions were selected; the results from the other five regions have been reported elsewhere (Langaas et al. 2002). Although the author did not participate in the selection of cases, a few things should still be mentioned about the selection criteria. One initial aim was to choose lakes before rivers, as the pilot study of the MANTRA-East project is Lake Peipsi. However, this idea was partly abandoned when it was realised that there were not sufficiently many lakes in Europe that were: 1) having significant environmental problems, and at the same time being 2) transboundary. Another selection criterion was that the transboundary water resource should be shared by at least one EU country and one candidate country and/or non-candidate country. Lastly, because of the choice of focusing upon transboundary water regimes, a requirement was that the selected regions had established formal co-operation in the form of international water commissions (Langaas, personal communication 2001). It should be observed that this last requirement only applied for the three cases reported on in this thesis.

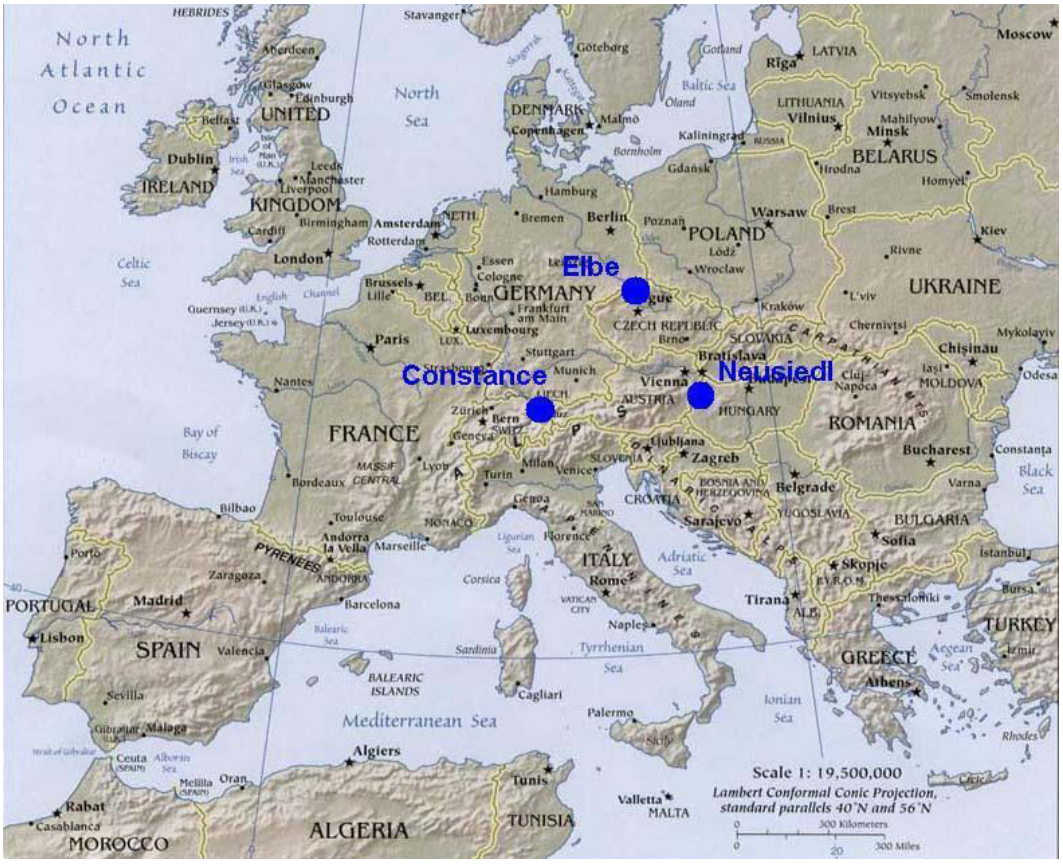

Figure 4. The selected case regions: Lake Neusiedl, Lake Constance and Elbe River.

Table 3. General characteristics of the case regions.

	Neusiedl	Constance	Elbe
Surface area/length	315 km^2	570 km^2	1090 km
Basin	1 120 km^2, shared between Austria (85%) and Hungary (15%)	11 500 km^2, shared between Switzerland incl. Liechtenstein (50%); Germany (28%); Austria (21%); and Italy (0,4%)	148 270 km^2, shared between Germany (65%); Czech Republic (34%); Austria (0,6); and Poland (0,2%)
Population	123 000 (110 inhabitants/ km^2)	1 500 000 (130 inhabitants/ km^2)	24 700 000 (165 inhabitants/ km^2)
Water uses	Recreation; reed harvest; scientific studies; fishing	Drinking water supply; fishery; shipping; recreation	Drinking water supply (via riverbank infiltration); industrial water supply; irrigation; navigation
Main environmental issues	Regulation of the water level; slight eutrophication	Eutrophication The situation has improved vastly since the late 1970's	Pollution of nutrients, heavy metals and organic substances From 1990-2000 there has been a great improvement of the water quality

4.4 Data collection and analysis

The material for the studies was collected using several data collection techniques. A large part of the material was collected through semi-structured interviews, performed in October 2001 – January 2002. In total, 19 persons involved in the work of the water commissions were interviewed. These persons can roughly be divided into two types. The first type of interviewees was commission-delegates, i.e., decision makers in the commissions. The other types of interviewees were consulting experts, i.e., information providers, often members of commissions' working groups. Representatives from all countries involved in the co-operations were interviewed. Before the interviews, the interviewees received a document briefly describing the outline of the study and the main questions to be discussed during the interview. The interviews, which could be classified as focused interviews allowing open-ended questions (Yin 1994), were either performed as face-to-face interviews with one or two persons at a time or as sent-out-questionnaires followed by phone interviews. Each interview, lasting between 30 to 90 minutes, was tape recorded and transcribed. Because of the semi-structural nature of the interviews, the questions discussed at each occasion were not identical. However, some major questions were brought up at each interview. Besides the material from the interviews, other sources of information, such as treaty texts, reports, meeting minutes and Internet material were also collected.

The collected data was analysed *ad hoc* (Kvale 1997), i.e., different analysing techniques were used, in relation to the following categories:

- Information needs and strategies
- Data collection and analysis
- Information use
- Implications of the EU WFD

The data was coded according to specific classes when applicable, while in other cases; the transcribed material was condensed into

shorter sentences. For each case, a case study report was written.

With the case study reports as a basis, the material was analysed further. The results of the case study reports were compared, and analytical generalisations of the information management in transboundary water regimes were made, on the basis of the observed similarities of the regimes (paper II). Further, the observed information management of the Lake Constance regime was assessed against the information needs specified in article 13 and article 14 of the EU WFD (paper III).

4.5 Validity, reliability and weaknesses

Validity is related to the truth and the correctness of a statement. According to a positivistic view on validity, this is related to quantifiable measurements. However, in a wider perspective validity relates to the issue of whether a method examines what it is supposed to examine (Kvale 1997). Yin (1994) describes three types of validity. "Construct validity" is connected to establishing correct operational measures for the concepts being studied, i.e., an investigator must be able to demonstrate that the selected measures of an event, indeed, manage to correctly describe that specific event. "Internal validity" is considered in explanatory or causal studies, where certain conditions are shown to lead to other conditions. For the sake of this thesis, internal validity has not been considered. "External validity" deals with generalisations of the findings of a study.

Considering "construct validity", this was tried to be established through the use of multiple sources of information, such as interviews, reports and meeting minutes. The collection of information from multiple sources aimed at corroborating the same fact or phenomenon, through so called triangulation of the data. For example, when investigating the information needs of the commissions, the results were based both on the answers from the interviews, as well as the tasks stated in the legal agreements on which the co-operations are based. Another tactic for increasing "construct validity" was to let the interviewees review the case study reports. This reduced the risk of reporting incorrectly about the cases.

Regarding "external validity" or the generalisation of results from the case studies (predominantly paper II) this is a quite tricky issue. The same approach was applied to all three case studies for being able to compare the information management of the regimes, but also to be able to analytically generalise the results. Consequently, the same type of material was collected at each site, basically the same questions were asked at the interviews and the same frameworks were used for guiding the data collection and analysis. Despite the good intentions of increasing "external validity", the generalisations made should be taken with great precaution. It should not be forgotten that the studies report about the specific situations solely in the three regimes studied. Nevertheless, it might be reasonable to assume that the results might be generalised to well-established transboundary water regimes in Europe.

The aim with reliability is to assure that, if repeated by another person, the study would generate the same results as the first time (Patel and Davidsson 1994). Standardised procedures for data collection and analysis were used for increasing the reliability of the cases studies. For example, a question scheme was used to guide the interviews. However, the reliability of the data analysis could have been enhanced by, for example, letting two persons code the data in parallel and then compare the results. Due to lack of resources this was, however, not done.

A general comment, applicable to the studies in the thesis, is related to their completeness. It may not be excluded that, if allocating more resources and time, the results of the studies may have turned out somewhat differently. Weaknesses in the case studies may be connected to the fact that the regions were only visited once. Although the investigator managed to interview "key persons", such as the heads of the countries' delegations, the total

number of interviewees was not very large. Thus, a few more interviews could possibly have been performed and, additionally, some commission meetings could ideally have been attended. Another weakness is related to the examination of the commissions' communication of information to other groups of actors. This communication was only examined from a commission-point-of-view, without considering the opinions of the other actors, such as NGOs or stakeholders, also involved in the communication.

5. INFORMATION MANAGEMENT IN TRANSBOUNDARY WATER REGIMES

5.1 Description of the transboundary water regimes

In all case regions, legal agreements about co-operation in transboundary water issues have been concluded and operational components in the form of joint commissions have been established. The Hungarian-Austrian water commission was established in 1956, the International Commission for the Protection of Lake Constance (IGKB) in 1960 and the International Commission for the Protection of the River Elbe (ICPE) exists since 1990. There are both similarities and differences between the regimes (Table 4). The contracting parties are national or regional governments and there is in general little representation of stakeholders or other similar groups in the commissions. The commission delegates are not politically elected, but are civil servants, mainly highly educated technicians. The resolutions of the delegates are made by the principle of unanimity and are later to be approved of by the member governments. The mandates of the commissions differs somewhat. In the Constance and Elbe regimes, the focus is on protection of the water resource and improvement of the water quality, while in the Neusiedl regime the main focus is co-operation on technical and economic water management issues. It should be pointed out that, at least the Constance and Elbe regimes generally are regarded as very successful co-operations. The great improvements of the water quality in Constance and Elbe during the last decades are to a high degree considered as results of the work of the commissions (Blatter 2001, IWAC 2001).

5.2 Comparing information management in transboundary water regimes

The information management in the transboundary water regimes for Lake Neusiedl, Lake Constance and Elbe River was examined and compared. Additionally, the information management in the regimes was briefly related to information needs implied by the IWRM concept (paper II).

5.2.1 On differences in information management

The study revealed differences in the information management between the transboundary water regimes. The results indicate that of the transboundary commissions examined, the Elbe commission has the most comprehensive information management, followed by the Constance commission and, lastly, the commission for Neusiedl. This statement is based on the identification of the information needs, which showed that Elbe was the only commission seeing a need for information to stakeholders and the public (Table 5). Further, relating the data collection performed within the frames of the commissions to the DPSIR framework, it was shown that the Elbe commission had the most regular and systematic collection of (D,) P, S, I and R information (Table 6).

Table 4. Characteristics of the three studied transboundary water regimes.

Basin	Commission	Legal basis	Contracting parties	Mandates	Power of implementation
Neusiedl	Hungarian-Austrian water commission[1]	Treaty between the Hungarian People's Republic and the Republic of Austria concerning the regulation of water economy questions in the frontier region, 1956	Hungary and Austria	- make decisions on the practical solution of technical and economic water management problems and promote co-operation in water questions; - plan hydraulic works and approve of methods of execution and maintenance; - supervise, account for and accept jointly executed works and measures; and - suggest measuring operations and preparation of studies in connection with hydraulic construction work	The commission makes decisions by the principle of unanimity and the decisions are later brought up to and approved by each national government.
Constance	International Commission for the Protection of Lake Constance (IGKB)	Convention on the Protection of Lake Constance Against Pollution, 1960	Austria, Switzerland, the German federal states Bavaria and Baden-Württemberg[2]	- observe the status of the lake; - confirm the causes of pollution; - recommend co-ordinated preventive measures; and - discuss planned utilisation of the lake	Resolutions of the delegates are made by the principle of unanimity. The resolutions are given as recommendations to the bordering countries, which have to consider the recommendations and realize them in the best possible way according to national law.
Elbe	International Commission for the Protection of the River Elbe (ICPE)	Convention between the Federal Republic of Germany and the Czech and Slovak Federal Republic and the European Economic Community on the International Commission for the Protection of the Elbe, 1990	Germany, Czech Republic and EU	- identify major point sources of pollution and estimate pollution from diffuse sources; - propose limit-discharge-values and specific quality objectives; - propose and co-ordinate joint measurement programmes; - compile standardized methods for water quality classification; - propose actions for reduction of discharges of harmful substances and measures for avoidance of water pollution because of accidents; - describe the hydrological situation in the Elbe area; - provide information about various biotopes and propose improvements for aquatic and coastal communities; and - promote co-operation and exchange of information	Resolutions of the delegates are made by the principle of unanimity. The resolutions are given as recommendations to the member states and the implementation is up to the governments to decide upon.

[1] Commission for all border waters between Hungary and Austria.

[2] Liectenstein has one representative in the commission, the German federal government is observer of the commission work and the Association of the Lake Constance-Rhine Waterworks (AWBR) has one representative in the Board of Experts.

Table 5. Information needs (and uses) of the transboundary water commissions.

Information needs (and uses)	Category according to DPSIR framework	Basin
Observe and agree upon the current status of the lake/river	S, I	Constance, Elbe, Neusiedl
Examine to what extent problems are still present and if measures have had the intended effect	S, I, R	Constance, Elbe, Neusiedl
Identify causes of pollution	D, P	Constance, Elbe, Neusiedl (?)
Recommend preventive measures	R	Constance, Elbe
Discuss planned utilisation of the water resource	D, P, S, I, R	Constance
Communicate information to the public about status and improvements	D, P, S, I, R	Elbe

The Elbe commission can also be considered to most actively communicate information to the public by, e.g., regular meetings with the NGO community (Table 7). The least extensive information management was found in the commission for Neusiedl, where only S and I information is regularly collected and few channels are used to actively communicate information to the public. The information management in the Constance commission appears to be neither as extensive as in the Elbe commission, nor as moderate as in the commission for Neusiedl.

Table 6. Types of data collected according to the DPSIR framework. "+" indicates that data is regularly collected while "-" indicates that data is not regularly collected.

Basin	D	P	S	I	R
Neusiedl	-	-	+	+	-
Constance	-	+	+	+	-
Elbe	?	+	+	+	+

There may be several reasons for the differences in information management between the commissions. A hypothetical explanation may be that the differences are related to factors, such as the diversity and perceived significance of environmental issues in the basin, indirectly influenced by, e.g., the number of inhabitants, number and type of industries, and portion of agricultural land in the basin. Considering the relatively many different users of water in the Elbe river basin, causing pressures on the ecosystem, it may be

Table 7. Means for communicating information to interest groups and the public. "+" indicates use of the information channel while "-" indicates no use of the information channel.

Basin	Press conference	Technical reports	Internet	Newsletter	Workshops/meetings
Neusiedl	+	-	-	-	-
Constance	+	+	+	+	-
Elbe	+	+	+	-	+

argued that Elbe faces a higher diversity of environmental problems than Neusiedl, where the number of various users are less. If the range of environmental problems is large it may be assumed that this poses higher demands on management of different types of information, explaining – at least partly - the differences between the commissions. Further, the many water users in the Elbe basin might put a higher pressure on governments, to act for generating reliable information for decisions, compared to basins where the number of users is few.

Another explanation to the differences might lie in the history and mandates of the regimes. The Elbe regime is the youngest, concluded in 1990 in response to the severe pollution of the river. The mandates for the commission are the most extensive among the three cases, comprising tasks, such as identification of major pollution sources, co-ordination of monitoring programmes, and suggestion of remediation measures. The Constance regime was set up in 1960 as a response to the increasing phosphorous levels in the lake, and subsequently the main task was to halt the eutrophication of the lake. The regime for Neusiedl, set up after World War II, is actually not committed to protect the water of the lake. The main focus is to take decisions on the practical solution of technical and economic water management issues, all along the Austrian-Hungarian border. Considering the increased awareness of environmental degradation of water resources in the last decades and the notion of an IWRM approach as a solution to the problems, the mandates of the commissions are partially outdated and probably reflect the point in time when they were set up. Additionally, the acute reasons for the establishment of the regimes may also play a role in explaining differences in information management.

5.2.2 On similarities in information management

Although there are differences in information management between the studied regimes, similarities can also be distinguished. One common feature of the commissions is that they all are expert/technical commissions. This has been referred to as the technical/scientific paradigm in river basin accords (Milich and Varady 1999). In this paradigm, experts, often hydrologists and engineers, are given broad authority to prioritise issues to be addressed, choose tools and targets, and determine the extent of public involvement. The weaknesses of this paradigm is according to Milich and Varady (1999) that decisions on critical social/environmental policy are allocated to engineers, who often are not capable of assessing the potential adverse effects of their decisions.

This technical domination of the studied commissions is reflected in several ways. It is shown in the information needs, which are mainly defined with the commissions' own needs in minds, and in the regular data collection, which is dominated by S and I information, collected through monitoring of physical, chemical and biological parameters. Further, the paradigm is also visible in the means for communicating information to the public,

which is mainly done through passive channels.

The presence of the technical/scientific paradigm in the studied commissions appears not to be in accordance with information needs of IWRM. For example, S and I information dominate the regular data collection performed within the frames of the commissions. Clearly, S and I information from monitoring is needed and according to van der Zaag and Savenije (2000) the gathering and sharing of such information is a basic requirement for building mutual trust between member governments. However, for a more integrated management of water resources other types of information, originating from the basin are also needed.

5.3 Assessing information management in the Lake Constance regime against information needs of the EU WFD

The information management in the Lake Constance regime, IGKB, was related to the information needs of article13 (river basin management plans) and article 14 (public information and consultation) of the EU WFD (paper III).

Although the Lake Constance regime generally has been regarded as a very successful regime, being able to solve the problem it was set up to deal with (Blatter 2000), the information management appears not to be fully in accordance with what might be needed according to the WFD. The reasons for this might possibly be traced back to the point in time when the regime was set up, in 1960, and the fact that its main task was restricted to reduce the phosphorus levels in the lake. Nevertheless, lessons might still be learnt from this case on issues to consider for the future regarding information for fulfilling the needs of the WFD.

Relating the content of a river basin management plan to the information management of the IGKB (Table 5-7) it is recognised that the commission today does not fulfil the needs outlined in article 13 of the directive (cf. Table 2). For example, the IGKB does not manage information for economic analysis of water use. Although the IGKB collects information on point sources of pollution, the commission does not perform complete inventories of all pressures and impacts of human activities affecting the status of the water in the lake. The IGKB collects monitoring data, so the status of the lake is continuously assessed, which is something that should be included in the river basin management plan. However, it is reasonable to assume that the monitoring programme will have to be adjusted – with regard to the parameters measured – according to the needs of the directive. Considering response information, the IGKB occasionally works out guidelines. Historically these guidelines were especially dealing with recommendations on measures for reducing the phosphorus levels in the lake. The latest guidelines from 1987 are, however, broader in scope and covers issues on, e.g., fishery, shipping and water protection in spatial planning. Thus, the commission manage responses information, but again this information needs to be adjusted to the requirements of the directive.

Concerning the active involvement of all interested parties (article 14), it is doubtful if the IGKB fulfils this request. As the directive is not very specific about the forms and extent of public participation, this makes it consequently hard to assess and relate the activities of the IGKB to the needs of the directive. Despite this uncertainty, some general remarks can still be made. As it is today, stakeholder groups and the public are generally not involved in the work of the IGKB. No models, such as citizen juries or focus groups, are currently practiced by the IGKB for involving interested parties. Thus, the fora and opportunities for interested parties to comment upon the planned activities of the IGKB are limited and not in line with what, at least, is anticipated in the directive.

6. CONCLUDING REMARKS

The review of theories, models and frameworks that can be applied for studying the role and use of information in transboundary water management showed that a number of quite varying approaches can be used. None of these approaches is all-encompassing, nor reflecting the "true" picture of information collection, transfer and use. On the contrary, the theories, models and frameworks may be regarded as complimentary, each reflecting different parts or views on the role and use of information in IWRM.

Based on the information management of the three regimes studied, the following general conclusions can be drawn:

- Information needs tend to be defined by experts without direct involvement of policy and decision makers from member governments, stakeholders or other interest groups.
- Although there are variations between the regimes, the regular data collection is dominated by state and environmental impact information.
- The commissions mainly use passive channels for communicating with stakeholder groups and the public and these groups are, thus, not actively involved in the management of the water resource through the activities of the commissions.

If the commissions in the future are to meet information needs implied by the concept of IWRM and the EU WFD, the following recommendations can be given:

- Definition of new information needs, taking into account the needs of stakeholder groups and the public. Recognising information needs of other groups will probably require involvement of these groups already in the definition process.
- A more balanced data collection, where not only state and environmental impact information, but also driving forces/pressures and responses information originating from the basin, is collected.
- Development of more participatory fora and mechanisms, such as workshops and scenario planning models, for communication with stakeholder groups and the public.

7. FUTURE RESEARCH

There are many options for future research. Based on the results discussed in the thesis, the author particularly sees three aspects of special importance for further investigation.

Firstly, the general conclusions on information management in transboundary water regimes may be tested for their validity by examining the information management of more formal transboundary water regimes in Europe.

Secondly, the information management in a transboundary river basin ought to be more thoroughly examined, by identification of key actors and examination of the communication of information between them.

Thirdly, the implications of the EU WFD on transboundary water management deserve further attention. As an initial step, the portion of international river basin districts should be determined and states' attitudes towards co-operation examined.

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