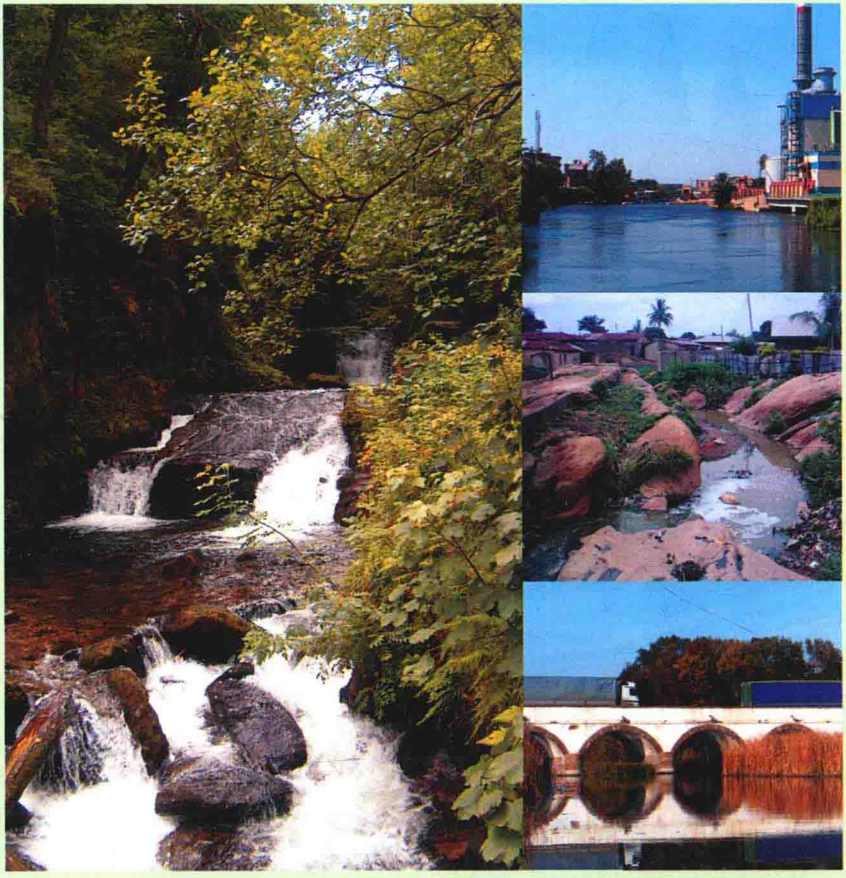
Information Needs for Water Management



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Preface

This book is based on my experiences with specifying information needs in a range of projects, the details of which were the basis of my PhD thesis finalized in 2011. Working on my thesis I realized the difference between working on a manuscript that needed to be scientifically sound and a book that can support people in their work. The idea grew after finalizing the thesis—that it would be useful to turn the work, a scientific endeavor, into a practical guide, applying the methodology developed in the thesis. Such a book would offer hands-on support to practitioners in developing a process to specify information needs. This book is the result of that idea.

This book basically has two purposes. One is to develop the reader's understanding of the role and use of information in decision making, in the context of water management. The other is to provide support, by means of a structured approach towards specifying information needs.

The first chapter in the book gives a general overview of the policy making process, the role of information in that process, and the mismatch between the information that is produced and the information that is considered necessary. The second chapter describes the information cycle; the process of producing information. It describes the phases in the cycle and the way it can be applied in developing and improving that process. The other chapters follow the logical steps in developing and implementing the first phase in the information cycle; the information needs a specification process. They describe the design of the process, an analysis of the water management situation as the first step in deciding policy objectives, the structured breakdown of policy objectives into information needs, and the final steps to be able to develop the following phases of the information cycle towards an overall information network. Each chapter starts off with a general

description of the issue at hand, followed by a hands-on description of the steps to be undertaken. Moreover, to support the reader, each chapter begins with an overview of the content and lessons that follow. Each chapter also ends with a number of practical exercises to help the reader better understand the contents and gain experience in specifying information needs.

For detailed information on the subjects covered in the book, the reader may consult the list of references. Moreover, where relevant, I have included boxes that provide background information on specific topics. The boxes are, however, not necessary for proper understanding of the book.

I hope this book will show readers that it is possible to specify information needs in a structured way and therewith provide sufficient support to elaborate on the information needs in their organizations.

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Writing a book is not the work of one person alone. I would not have been able to write this book without the guidance I received on my PhD Thesis from my supervisors Wim Cofino and Katrien Termeer from Wageningen University and Research Centre (The Netherlands), and Euro Beinat from University of Salzburg (Austria) and Zebra Technologies Corporation (Chicago, USA). The invaluable comments from Andrew Quin, Royal Institute of Technology (Stockholm, Sweden), who reviewed an earlier version of this book, have improved the work.

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1

Introduction—Setting the Scene

This chapter deals with the role of information and monitoring in water management and stresses the importance of specifying information needs to improve the production of information. Starting off with the global water management challenges it will introduce the policy process and the role of information therein. It will also explain the nature of the water information gap and the implications this has for assessing policy makers' information needs. Understanding the policy process and the role played in it by information is essential to be able to link information production to this process. Finally, the chapter will discuss the nature of policy problems and how they can be structured. After studying this chapter the reader will be able to:

- Explain the nature of the water information gap
- Explain the policy making process and the policy life-cycle
- Explain the role of information in the policy making process

1.1 INTRODUCTION TO WATER MONITORING

1.1.1 The Global Water Management Challenge

Water is an essential natural resource with limited availability. There is plenty of water on the Earth and in the ground, but it is not distributed evenly over the Earth's surface and in time. Many people have too little water to grow their crops, while on the other hand floods frequently threaten lives and harvests. Also, the quality of the available water is often poor and access to safe drinking water is lacking. Besides this, natural systems like the Aral Sea and other examples are under severe pressure from (often competing) human demands[1-4]. Water

management, or when put in a broader context, water governance[5, 6], should be able to manage these issues.

It is generally acknowledged that for the abovementioned reasons, water should be managed in a sustainable way[1, 7]. This denotes that water policy must aim at developing in such a way that the present needs are met without compromising the ability of future generations to meet their needs[8]. Integrated Water Resources Management (IWRM) is sometimes questioned for not being comprehensive enough[9] or too vague[10], but is nevertheless generally considered as the proper concept for achieving sustainable water management[5, 6, 11]. The role for policy makers in this is to reach out for sustainability by directing progress towards integrating economic, ecological and socio-cultural dimensions for all human activity[12]. Sustainability, in this sense, requires balancing a variety of needs including future needs that are not yet clear. This is the larger context of water policy and water management.

1.1.2 The Need for Information

Effective water resources development and management is not possible without adequate information and benefits when the quality of information is improved[13-16]. Information on relevant characteristics supports and guides decision makers to determine the best ways to proceed and is the basic source to evaluate the effects of specific policies[17, 18]. Vast effort is hence put into the collection and dissemination of environmental information, especially by governments and government-related institutions[19].

The need for information in the field of water quality management has steadily increased over time. Water quality management was virtually non-existent up to approximately 1850, by which time local environmental conditions deteriorated severely with foul smelling, deoxygenated water as a result of industrialization[20]. The rapid developments in urbanization and industry after World War II in western Europe led to deterioration of the quality of surface waters. New industrial processes emerged, that increased the standard of living. These same processes produced increasing streams of wastewater containing organic loads, heavy metals, dyes, etc., Studies into the water quality situation were conducted whenever locally problems occurred. However, slowly water managers came to realize that these problems became long lasting and omnipresent. Irregular studies were not enough to deal with the pollution and a structured system of information gathering was needed. Regular water quality monitoring was not established until the 1950's in the USA, the former USSR and in a few European countries and extended to Canada and most of western Europe in the late 1960's and 1970's[21].

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Box 1.1 Syndromes of river changes[22]

Direct and indirect human pressures on aquatic systems over centuries have led to syndromes of river change. These syndromes can be cured, which takes decades for some and centuries for others. Meybeck[22] distinguishes the following syndromes:

- Flow regulation, that is generally achieved through the construction of dams and reservoirs and sometimes through water diversions. The ecological impacts of such extreme regulation can be important.
- River fragmentation, where river courses are interrupted by multiple dams and reservoir cascades that greatly limit their longitudinal connectivity or change in lateral connectivity due to channelization, levees and embankment construction. Such fragmentation also results in major changes of the aquatic biota particularly fish (e.g. migratory species) and intersticial fauna.
- Neo-arheism is the dramatic reduction of river flow due to consumptive use of water and/or to diversions, particularly resulting from irrigation, but it may also be related to urban water demand in some dry regions. The impacts of neo-arheism are mostly observed in the coastal zone which is no longer supplied with fresh water, thus changing the salt balance, with essential nutrients, organic matter and sediments.
- Sediment unbalance is the gradual or rapid change of sediment transfer, suspended matter or bedload in river systems due to land-use changes and to reservoir building. As a result, most of the sediment is redeposited in foothills, river beds and floodplains and, more recently, in reservoirs instead of the river mouth.
- The salinization as a result from the release of dissolved salts from industrial and urban sources. The salinization process may result in severe limitations of water uses.
- The chemical contamination is related to most human activities such as mining and oil extraction, industries, urbanization and transport, agriculture.
- Acidification of continental waters is related to atmospheric fallout of sulfuric and nitric acids.
- Eutrophication, an excess of algal development in water bodies due to nutrient enrichment. The nutrient unbalance can lead to anoxia, deteriorating the aquatic life.
- Thermal unbalance that may be caused by thermal pollution or, e.g., by reservoirs' operation. Its impacts on the aquatic biota may be important.
- Biological introductions that result mostly from rapid increase of fluvial transport and of ocean transport through ballast waters. Biological introductions may have dramatic impacts on water resources and on aquatic ecology.

Meybeck and Helmer[23] give an overview of some of the major pollution problems arising over the years in industrialized countries (also see Box 1.1). They show that fecal and organic pollution were

important problems even before 1900. Salinization, metal pollution and eutrophication emerged before the 1950s. Around the 1950s and 1960s, problems with radioactive wastes, nitrate and organic pollutants became apparent. This illustrates that every now and then new problems are manifested. In addition to what Meybeck and Helmer describe until 1989, in the late 1990's, among others, problems arising from oestrogenouos substances, tributyltins, and drugs became apparent[24-26]. With each emerging environmental issue, water management becomes more complex and, connected to this, each new problem leads to new information needs. As a consequence, there is a continuous push towards increasing the water quality monitoring efforts.

Moreover, realization grew that water management was not only a quality issue but had to be integrated over the various functions and uses of water. A balance was needed between ecological, economic and social issues[27, 28]. This is also where IWRM as a concept developed. In this way water monitoring developed over a few decades from measuring a few simple parameters into a complex process where many different parameters are measured in various frequencies on various locations.

Water quality monitoring nowadays is based on the supposition that water management is not possible without adequate information (Box 1.2) and that information should help decision makers arrive at sounder, faster and more transparent decisions[17]. The supposition is that information assists decision makers in rationalizing the choices made, that is, that the choices are based on objective criteria such as the minimization of costs or the maximization of benefits[35]. The overall premise of this book is that decision makers need information to help them make better informed decisions. Reality is usually more complex than that and this book will also try to describe possible deviations from the theory to a certain extent, based on available literature (Box 1.3).

Box 1.2 Access to environmental information

Access to environmental information is generally considered to be a fundamental right[29-32]. The US National Environment Policy Act (NEPA) already in 1969 explicitly stated that information regarding environmental problems must be made available to States, Counties, Municipalities, Institutions, and other entities, as appropriate[18, 33]. Free access to environmental information is however no absolute right; there are an extensive number of exemptions due to, for instance, security issues. And there are practical impediments like accessibility of, especially older, data. With digital archives access to data becomes easier, but the free access to information is now sometimes purposely turned into flooding people with information. De Villeneuve[34] gives a more detailed discussion on the benefits and limitations of access to environmental information.

Box 1.3 The importance of long-term studies

A review by the European Environment Agency (EEA)[36] of 14 major environmental issues in the late 20th century indicated that long-term environmental studies had a key role to play in the identification of environmental problems. The long-term data series were able to point out the problems and policies and measures could be developed accordingly. Although changes in policy often take longer to achieve than environmental scientists believe wise, the examples from the report show the importance of maintaining a wide range of long-term monitoring studies in order to identify emerging issues. Moreover, many contemporary environmental issues are global in scale and these require more coordinated and harmonized approaches to long-term monitoring.

1.1.3 Impact of Information

Talking about information also implies disseminating and communicating the information. Denisov and Christoffersen took an approach towards information in policymaking, of looking at the impact of information on decisionmaking[37]. They state that decisions are not only made on the basis of individual and institutional considerations, but are strongly influenced by visible and hidden systems of interests. The role of information is to help promote, develop and establish more formal management frameworks that are supposed to modify and steer the behavior of people or organizations in the desired direction, such as laws or economic mechanisms.

There are several steps (Box 1.4) to take before information can create an impact. The information produced is generally brought out in the form of maps, graphics, books, papers, etc. The way this information is communicated—through journals, the Internet, mass media or conferences—is important to reach a specific target group, like scientists, decision makers or the public at large. This target group can develop their own ideas based on this information. These ideas, in turn, can lead to changes in, for instance, laws and policies, or even values. Such changes can then lead to altered behavior which could finally result in better quality environment[37].

Box 1.4 The flow of information in water management policy

The tasks in water management and the flow of information between these tasks has been identified by Van Bracht[38]. In the process of developing water management policies, social, economic and ecological considerations are identified.

The demands of interest groups like drinking water suppliers, industry, agriculture, recreation, transport (navigation), and nature conservation are examined. Potential uses of the water system are determined by the properties of that water system. The policy, together with the demands of the

interest groups and the potential uses determine the assignment of functions to the water system. These functions are limited by the societal constraints as put down in the policy, the demands the uses put on the water system as depicted by the interest groups and the limitations as set by the properties of the water system.

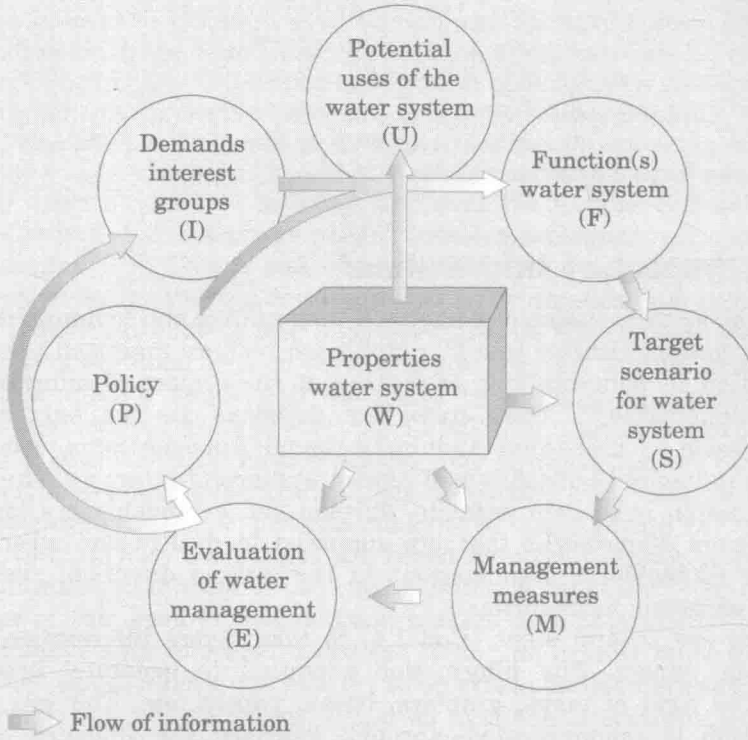

Figure 1.1 Flow of information in the water policy process

Derived from the functions, together with information on the properties of the water system, target scenarios can be developed that represent the conditions under which the water system can satisfy the demands as set by the assigned functions. These scenarios provide information for management measures like technical measures (for instance, construction of a weir) or legal measures (like imposing levies). Again these measures should be tuned to the properties of the water system. The water management will be evaluated by checking whether the measures have had the desired effects. This requires comparing the (changes in) properties of the water system to the management measures made.

The evaluation now provides new input to the policies and interest groups to start development of new water management and the cycle starts again[38, 39]. The entire flow of information as described here is coordinated from the information environment of the water management organization. Information to support environmental decisions in this framework should

cover a wide range of issues and originates from various sources. Information from each of these sources is complex, often abundant, contradictory, having a differing quality, and is focused on scientific use rather than political use, as a result of which it is hard to access by policymakers or the general public. Information management is concerned with coordination and sharing of information, and translating this variety of information into a coherent set, and is as a result an important function in water management.

If information is to be effectively disseminated, it is apparent that good communication strategies need to be developed, linking to the audience that is to be reached. Creating effective communication tools therefore requires a strategy that can be developed by asking and answering a series of basic questions[40]:

- What is the objective? What should be achieved with this information? Is it raising or increasing of awareness? Is this information intended to change behavior or is it meant to start a dialogue with the public?[41].
- What is the target audience? Should the information focus on experts, on policymakers, or on lay people?
- What is the overall message that is to be conveyed? It is generally useful to frame the message in terms of problem and solutions.
- What format will be used to convey the message? Will it be a report, a presentation, a video, a conference, or maybe a combination of these?
- How will the message be distributed? Is it by means of a standard mailing list, by hooking up with the mass media, by dumping it all on a webpage, or by using social media?
- How will the success of this strategy be evaluated? Is it done by counting the number of references included in literature, quotes in the mass media, or should there be a notable change in opinion among the public at large?

Let us take a closer look at some of these questions. One essential question is: what is the message that is to be conveyed? Messages focusing only on the magnitude of an environmental problem (for instance, the state of the environment) or only on possibilities available for environmental action (for instance, new technologies) are generally less effective than messages that present both a problem and a solution in an interconnected manner. This enables the presented information to become more meaningful where information users perceive the pattern and also helps them to make changes (that can make information a constitutive force, see Section 1.2.9). Information on a problem, therefore, has to be produced in close co-operation with policymakers who can include solutions, On the other hand, in real life it may very well happen that information is used to justify decisions after, rather

than before they are taken (information to direct decision-making, see Section 1.2.9)[37].

If information becomes a 'perception of pattern' or a 'constitutive force' (also see Section 1.2.9) it is capable of generating discussions. Moreover, information can act to generate processes whose value for decision-making at the end may be greater than that of the original 'catalyzing' information. This specifically happens when exchange of information is part of a participatory process where decision makers and other stakeholders are both closely involved in the information development process. Three effects of a participatory approach can be discerned[37]:

- Strengthened capacities of process participants to generate and handle environmental information. Networks of organizations and individuals involved in the process of collecting, processing, and producing information form a solid basis for production of information in the future. The people involved are aware of the purpose of the activity and are able to influence the collection of information to include their own interests and will therefore have more confidence in the information produced;
- Improved quality and acceptance of generated information due to multi-lateral inputs and controls. The participatory process means that information is subjected to quality control all through its production and not only at the end. As participants' varying perspectives are incorporated into the process , the resulting information reflects diverse values and interests, thus making the final product more salient (see Section 1.2.2);
- Better awareness of the findings among process stakeholders due to their direct involvement in the process, thereby attaching higher value on the findings and higher acceptance of the consequences of the findings. This also has influence on a wider audience as the stakeholders that participated have an inherent interest in broadcasting the results of the process to their acquaintances. Incorporation of major decision makers is likely to influence policy decisions.

Changing the information behavior - that is how individuals approach and handle information including searching for it, using it, modifying it, sharing it, hoarding it, even ignoring it - of an organization[42] towards a participatory approach and better cooperation, strengthens these effects. People in an organization that are used to such a participatory, social learning approach will be more open to the exchange of views and opinions and will be more aware of the process.

What determines the success of the communication strategy? Assessing the overall impact of information can be difficult for two reasons[37]:

1. Information itself, in the form of raising awareness among the public at large, is a relatively weak instrument of environmental

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