MAKING MONITORING TAILOR-MADE IN EUROPE

Jos G. Timmerman, Martin Adriaanse and René M.A. Breukel

Institute for Inland Water Management and Waste Water Treatment RIZA, PO Box 17, 8200 AA Lelystad, The Netherlands.

Biographical Sketch of Authors

Authors work as senior projectleaders at RIZA at the Department of Information and Measurement technologies and are involved in the Dutch national inland water quality and quantity monitoring. They are also involved in the development of guidelines for river water monitoring under the Helsinki 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes of the United nations Economic Commission for Europe. In their position, they have contributed to the development of the concepts and ideas in the various projects, as described in this paper.

Abstract

Various initiatives in Europe in the 1990's have led to a working concept in providing information for water management; tailor-made monitoring. This concept comprises providing accountable and cost-effective information that supports water management action. The concept has been thoroughly discussed and tested and has proven to be a valuable addition to monitoring practices in Europe. Major elements of the concept are: 1) water management analysis, to identify the major issues in a water body; 2) inventories and surveys, to provide additional information to the water management analysis; 3) evaluation of legislation, to find if the aims of legislation are fulfilled; and 4) specification of information needs, as the basic step for the development of a monitoring network. The paper discusses the backgrounds of the tailor-made concept and the monitoring practices in Europe.

Introduction

In the early 1990's, in European countries a shared interest was growing in working together to prevent deterioration of water quality in transboundary waters and to ensure reasonable and equitable use and joint conservation of transboundary waters. This concern is expressed in the Helsinki 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes (ECE 1994). Under this convention, Guidelines for water-quality monitoring and assessment of transboundary rivers were drafted by the Task Force on Monitoring and Assessment and were adopted by the Committee on Environmental Problems in 1996 (ECE 1996). The international workshop Monitoring Tailor-Made was organized in 1994 to provide a forum for experts from many countries to exchange experiences in monitoring and obtaining better water information. A major conclusion from this workshop was that monitoring is justified by the value and use of the resulting information. Monitoring should therefore be accountable for an information purpose and cost-effective, while the resulting information should support action (Adriaanse et al. 1995). The workshop Monitoring Tailor-Made was repeated in 1996, this time putting emphasis on information strategies in water management. From this workshop it was concluded that water quality monitoring should look beyond chemical, physical and biological properties of water bodies to provide information for water management and that policy-makers and the public should be stronger involved in developing monitoring (Van Luin and Ottens 1997). Also, in 1995, the European Commission started a fundamental rethinking of its water policy. This resulted in 1996 in a proposal for a Water Framework Directive, propagating the philosophy that water quality should not be uniformly defined throughout Europe, but to define ecological objectives for individual river basins (European Commission 2000).

In this paper, these developments and their implications for monitoring in Europe will be discussed.

Tailor-made monitoring

Water management has become increasingly complex over the last twenty-five years. Surface waters support many functions and uses, like recreation, transport, drinking water supply and ecological quality, with often conflicting requirements, while many different issues pose problems on the use of water bodies (figure 1). Next to this, water system problems have become more complex and diverse (Somlyódy 1994), and require interrelation of various disciplines in the form of integrated (and in the future comprehensive) water management (De Jong et al. 1994; Raskin et al. 1997) while the information age provides the opportunity to handle enormous amounts of data and information (Timmerman et al. 2000). Ward et al. (1986) described this "data-rich but information-poor syndrome". To find an answer to the question on how monitoring could provide more effective information, the workshop Monitoring Tailor-Made was organized.

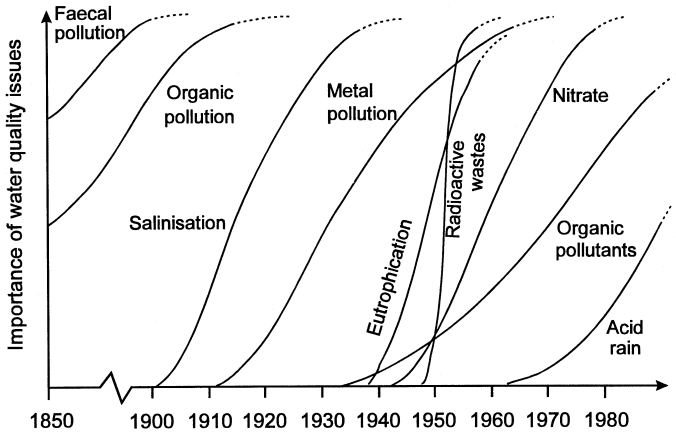

Figure 1 The sequence of water quality issues arising in industrialized countries (Meybeck and Helmer 1989)

From the first workshop it was concluded that the design and operation of monitoring systems, which support water management today, are characterized by uncertainty, particularly with respect to being accountable for a purpose. Too often in the past, monitoring was characterized by occurring without specified information objectives, a tendency that more data is better and the use of high tech is always an improvement. The new paradigm about monitoring is that it should be cost-effective, accountable, and justified by value and use of

information. Monitoring should be integrated across disciplines, thus making it more complex. Further study in this respect will be needed. Next to this, as ecosystems do not respect human boundaries between local governments or countries, there is a need for unbiased water information as a basis for "integrated watershed management" (Adriaanse et al. 1995).

The Guidelines for water-quality monitoring and assessment of transboundary rivers (ECE 1996; ECE TFMA 1996) follow along the lines of these conclusions. The guidelines focus on the river basin approach and on an integrated assessment of the river water quality. The important elements for an integrated assessment are 1) the functions and uses of a river basin (e.g. use for abstraction of drinking water or ecological functioning of the basin); 2) the problems and threats to these uses and functions (e.g. eutrophication or increased concentration levels of micropollutants); and 3) measures to counteract problems (e.g. improvement of waste water treatment) (?).

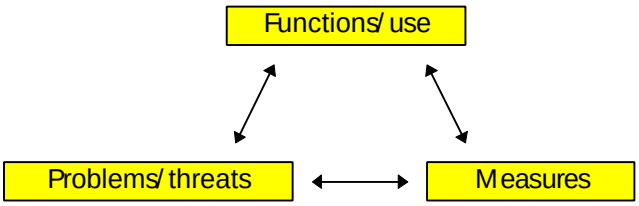

Figure 2 Core elements in water management (ECE 1996)

To define information programs that provide suitable information, there has to be a mutual understanding of the issue at hand. Therefore, information producers and information users should jointly specify the information that is needed. To provide a common basis for this discussion, the monitoring cycle (?) as a shared framework has been developed (ECE 1996). As an example, improvement of the interaction between monitoring and risk assessment of chemicals can be mentioned (Timmerman and Van de Guchte 1998).
The monitoring cycle describes the process of information production as a chain of activities, closed by the management action of the decision-maker (Adriaanse and Lindgaard-Jørgensen 1997). Going from information required to information obtained, the following steps can be distinguished:
- information users, as part of the monitoring cycle, should, in co-operation with information producers, decide upon the characteristics of the information that is needed;
- information producers will, in co-operation with information users, decide upon the best way (i.e. strategy) to collect information;
- the actual measurements, after network design through sample collection, laboratory analysis and data storage, form the next step in the monitoring cycle;
- the data collected are analyzed statistically, the results are aggregated and interpreted relative to the information requested, and information statements are made;
- the resulting information is presented and transferred to the information users in a proactive manner.
Each step in the monitoring cycle puts requirements on the previous step of the cycle. If, for example, a trend with a defined reliability has to be calculated, sampling has to take place with a certain frequency, depending on the variability of the data. Thus data analysis puts requirements on data collection. Also, each step limits the possibilities in following steps. For example, if the sampling frequency is too low, no reliable trend can be calculated (Cofino 1995). By going through the information cycle both clockwise and counter-clockwise, in an interactive way, these requirements and limitations may be made explicit (Timmerman et al. 2000).

The monitoring cycle is an important basis for the ECE Guidelines. An essential aspect of this monitoring cycle is that it starts with specification of information needs (ECE 1996). Proper identification of information needs principally requires that concerns and decision-making processes of information users are defined in advance (Timmerman et al 1997).

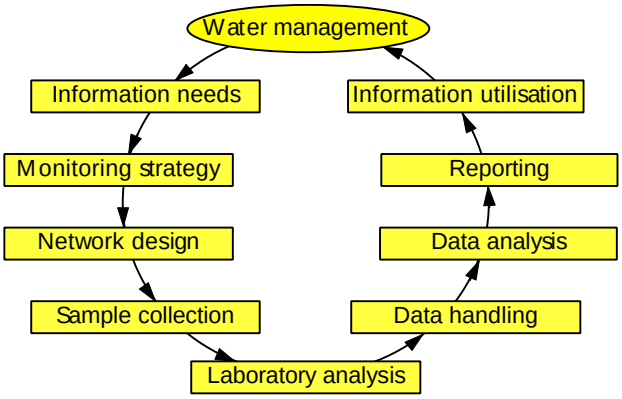

Figure 3 The monitoring cycle (ECE 1996)

The international workshop Monitoring Tailor-Made II led to the conclusion that there is an increasing demand for methodologies to enable specification of information needs as well as the transfer of information resulting from monitoring to the actual users. As policy makers and water management authorities are increasingly being challenged to cope with conflicting interests from pressures and functions of their waters (Ward 1997), and therefore have information needs that are not restricted to the 'traditional' disciplines like physics, chemistry and biology, such tailoring of monitoring networks increasingly involves other disciplines such as information analysts, economists and sociologists. This, however, requires more extensive communication between the different fields of expertise. As many organizations in the field of monitoring have to deal with budget cuts, the cost-effectiveness of monitoring activities is becoming more important. And as every river basin has specific properties and problems, there is no universal monitoring program or even a universal strategy to develop monitoring networks (Van Luin and Ottens 1997).

The principle of tailor-made monitoring is to provide the right information to support management decisions. Tailor-made information is information that is effective: the information product is tailored to the questions, and efficient: the information is provided at a reasonable and affordable price (Adriaanse 1997). The process of monitoring is described through the different steps in the monitoring cycle (ECE 1996). Two essential steps in this cycle to provide tailor-made monitoring are 'Information needs' and 'Monitoring strategy'. Specification of information needs is essential to make monitoring effective. The requirements for the information product are laid down through a thorough investigation of what information is needed for water management; what questions need to be answered and how precise the answers must be.

A method for the specification of information needs has been developed within the Dutch Directorate-General of Public Works and Water Management (Rijkswaterstaat). This method provides a structure defining what activities to perform at what stage. It comprises five steps: 1) Exploration, to mark out the project; 2) Tuning, to communicate and verify the starting points; 3) Elaboration, to come to detail; 4) Conclusion, to communicate and verify the results; and 5) Completion, to document the results and to plan following steps. Major issues for this method are insight in the organizations involved in producing and using information and their responsibilities in the process, which is elaborated in the step 1: Elaboration, and the communication between information users and information producers in the steps 2: Tuning and 4: Conclusion (Timmerman and Mulder 1999).

The next step in the monitoring cycle is elaboration of the monitoring strategy, which is needed to make monitoring efficient. Specifying the monitoring strategy implies looking for cost-effective solutions, which are not necessarily the best technical solutions. It also means looking for strategies that are tailored to a specific water system, its functions and its problems (ECE 1996). For instance, there is no need to buy a GCMS if there is no problem with organic micropollutants in the river basin.

The European Union Water Framework Directive (WFD) has been drafted in 1996 and is under discussion since. It is aiming at incorporating all requirements for management of water status into one single system and at coordinating all the different objectives for which water is protected (ecology, drinking water, bathing water, particular habitats) and to fill any gaps. It also aims at coordinating all the measures taken on individual

problems and sectors to achieve the objectives so defined, and at defining the relationship between emission limit value measures and quality standards. Finally this should lead to an increased public participation in water policy by providing for greater transparency, with the advantages in enforceability which will result. Important aspects in the WFD are the river basin approach and integrated water management approach. In the center of the action to achieve this all is the river basin management plan. This plan should include an economic analysis of water use within the river basin to enable a more rational discussion on cost-effectiveness of possible measures (European Commission 2000).

Information is needed on the origin and effects of different water management issues, and the measures taken. The European Environment Agency uses the DPSIR causality chain (figure 4) as a framework to distinguish between the different aspects of an issue. Driving forces describe the human activities, like e.g. urbanization and agricultural activities, that are the main sources of problems or threats. The pressures describe the stress that the problem puts on the functions and uses of the river basin. The state of the river basin is described in terms of concentrations, hydrological or ecosystem characteristics. The impact describes the loss of function or use like toxicity or bad taste for drinking water. Responses describe the policies that have been or are being developed to deal with the problem (EEA 1998).

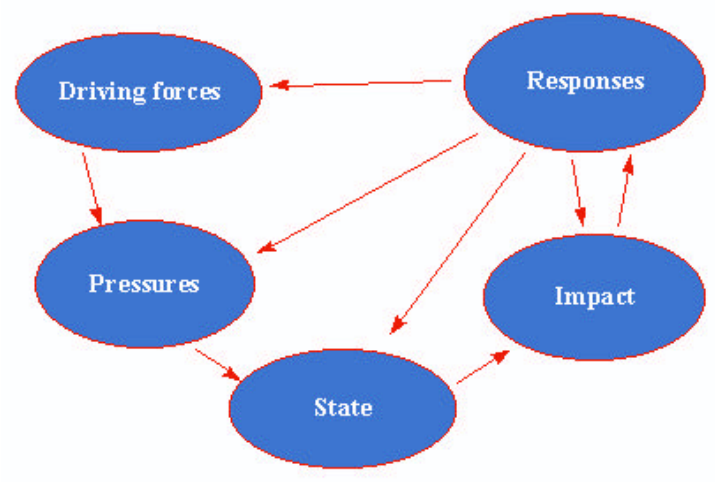

Figure 4 The DPSIR-framework (redrafted from EEA 1998)

Bringing theory into practice

In 1994, the international workshop Monitoring Tailor-Made was organized to discuss the concept of 'tailor-made design' as discussed in the previous section. From the workshop it was concluded that with this new concept, attention should be directed to integrate between the various disciplines involved and to integrate over administrative borders as river basins don't stick to such borders (Adriaanse et al. 1995). The workshop Monitoring Tailor-Made II, organized in 1996, focused on better applying the concept of tailor-made monitoring, using the monitoring cycle as a framework to fill in the successive steps in monitoring. From this workshop it was concluded that the tailor-made approach is embraced by many countries. Nevertheless, methodologies to implement this approach were still lacking (Van Luin and Ottens 1997). The workshop Monitoring Tailor-Made III, to be held in September 2000, will further investigate methodologies to implement the tailor-made approach.

The work of the UN/ECE Task Force on Monitoring and Assessment, and the ideas and concepts discussed in Monitoring Tailor-Made I were of major importance to the Guidelines for water quality monitoring and assessment of transboundary rivers (ECE 1996). The guidelines describe the tailor-made approach and use the monitoring cycle as an outline. The guidelines are not just an administrative exercise: in 1997 pilot projects in eight transboundary river basins including 10 European countries have started with one of the major objectives being demonstration of application of the guidelines. The experiences from both workshops Monitoring Tailor-Made I and II are used in these pilots and in turn experiences from the pilots have lead to a revised version of the guidelines in early 2000 (ECE TFMA 2000).

In the Netherlands in 1996, a program, "Monitoring Strategy 2000+", was started with the purpose of innovating the monitoring sector. This innovation is done by discussing the design of the future organization, investigating information needs and by implementing new technologies like remote sensing and models in operational practice. The monitoring cycle was introduced into this program and has proven very successful in communicating ideas and in planning strategies. Also in this program, a methodology has been developed to specify information needs. Several pilot studies have been conducted to test this methodology. In one study, the monitoring cycle was used to optimize a water quality monitoring network. From this study it was concluded that the monitoring cycle is an effective tool to structure evaluation and optimization studies of monitoring programs (Breukel 2000).

Discussion

The tailor-made concept in monitoring is embraced by many countries in Europe, but implementation of the concept is still under development. From the pilot projects, first experiences have drawn the attention to aspects that are important to apply tailor-made monitoring (from ECE TFMA 1999). These aspects will be discussed here.

- Water management analysis: Monitoring is performed to support water management. Before monitoring can start, a solid analysis of water management is imperative. Such an analysis should comprise an inventory of the uses/functions, problems, and management targets of the river. The uses and functions put requirements on the water quality and quantity. Problems and/or (future) pressures may conflict with these uses and functions. Next to problems in a river, a receiving water body (reservoir, lake, estuary, sea, etc.) may be impacted by the bad status of the river. In water management, targets are set to meet the requirements as much as possible. From these targets, measures are formulated and carried out.
- Inventories and surveys: By looking at the economic activities in a watershed (industry, agriculture, shipping, mining, etc.), a good idea can be constructed of the possible emissions of hazardous substances into the water. From the type of industry, for instance, the potential emissions can be determined. Calculation of loads from diffuse sources can provide additional information. Through an inventory of, usually, available information, a first estimate can be made of the potential problems. Surveys, short in depth studies of the actual situation, can provide additional information to confirm or enfeeble information from the inventory.
- Evaluation of legislation: Legislation provides a tool for water management, but also puts obligations on monitoring. One important issue of monitoring in this respect is to check if laws are really implemented, the second is to find if the aims of legislation are fulfilled. For transboundary cooperation, the existing legislation should be reviewed from the point of harmonization (e.g. of class systems) and comparability between countries, and if the standards are based on the existing risks.
- Information needs: The basis for monitoring is provided by specification of the information needs. Information needs should be the translation of water management, as described in the above-mentioned aspects, into questions on which information is needed. This specification of information needs requires involvement of both information users like policy makers and information producers like operators of a monitoring network.

Future developments

The various experiences mentioned above have led to new ideas on how monitoring will develop. As water management policy is shifting towards integrated management, the scope of monitoring is broadening towards social and economic information, and even to 'policy-monitoring', which can be described as monitoring of the implementation of policies like the degree to which policy measures have been carried out. Since this extending water management view will lead to even more information, there is a need to condense the available information. Development of indicators that comprise understanding of the issues without giving too much detail will provide for information compressing. Also, river basin management requires management and monitoring across administrative boundaries. Transboundary cooperation should therefore be one of the major issues in water management as well as in monitoring. The challenge of the future is to generate new methodologies to cope with these developments.

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