Convention on the Protection and Use of Transboundary Watercourses and International Lakes

STRATEGIES FOR MONITORING AND ASSESSMENT OF TRANSBOUNDARY RIVERS, LAKES AND GROUNDWATERS

INTRODUCTION

The present document is a draft version of the **STRATEGIES FOR MONITORING AND ASSESSMENT OF TRANSBOUNDARY RIVERS, LAKES AND GROUNDWATERS** which is being prepared by the Water Convention's s Working Group on Monitoring and Assessment, led by Finland. The "Strategies" will be finalized for adoption by the Parties to the Water Convention at their fourth meeting in October 2006. The present draft should provide the participants of the **Workshop on joint monitoring and assessment of shared water basins, including early warning and alarm systems**, (Tbilisi, 31 October – 2 November 2005) with a general analytical framework for joint monitoring and assessment. Participants to the workshop should read it together with the "**Overview of monitoring and assessment in Eastern Europe, the Caucasus and Central Asia**" which was prepared to provide a general outline of the current situation and main challenges in the region.

The Tbilisi workshop is the third one organized within the framework of the project Capacity for Water Cooperation (CWC) in Eastern Europe, the Caucasus and Central Asia, developed under the work programme of the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), and will build on the previous events: The Legal Basis for Transboundary Water Cooperation, Kiev, 22-24 November 2004 and Information Management and Public Participation, St. Petersburg, 8-10 June 2005 (for more information on the CWC project, please refer to http://www.unece.org/env/water/cwc.htm).

The workshop is funded by Finland and prepared by the Finnish Environment Institute and the United Nations Economic Commission for Europe (UNECE), in cooperation with the Ministry of Environment of Georgia and the Regional Environmental Centre for the Caucasus.

Information based on well organized monitoring programmes is the key prerequisite for accurate assessments of the status of water resources and the magnitude of water problems. These assessments are vitally needed to prepare proper policy actions at local, national and transboundary levels. Moreover, integrated water resources management in transboundary basins shared by two or more countries calls for comparable information. There is a need for a common basis for decision-making, which requires harmonized and comparable assessment methods and data management systems, as well as uniform reporting procedures.

This document explains the key principles and approaches of monitoring and assessment of transboundary watercourses. It is based on the earlier guidelines on rivers [1], groundwaters [2] and lakes [3]. The background document is particular compelling for those, who are involved in, or responsible for, establishing and carrying out cooperation between riparian countries as well as representatives of joint bodies (e.g. bilateral and multilateral commissions).

The document focuses on the underlying legal, administrative and economic aspects of monitoring and assessment. And it deals with the constraints and opportunities for cooperation.

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[1] Guidelines on Monitoring and Assessment of Transboundary Rivers, 2000, UNECE Task Force on Monitoring and Assessment, available at http://www.unece.org/env/water/publications/documents/guidelinestransrivers2000.pdf

[2] Guidelines on Monitoring and Assessment of Transboundary Groundwaters, 2000, UNECE Task Force on Monitoring and Assessment, available at http://www.unece.org/env/water/publications/documents/guidelinesgroundwater.pdf

[3] Guidelines for the Monitoring and Assessment of Transboundary and International Lakes, 2003, UNECE Working Group on Monitoring and Assessment available at http://www.unece.org/env/water/publications/documents/lakesstrategydoc.pdf and at http://www.unece.org/env/water/publications/documents/lakestechnicaldoc.pdf

CHAPTER 1: BASIC PRINCIPLES AND APPROACHES

Monitoring is usually understood as a process of repetitive measurements/observations, for defined purposes, of one or more elements of the environment according to pre-arranged schedules in space and time, using comparable methodologies for environmental sensing and data collection. Measurements/observations are to be made and samples are to be collected as far as possible at the same locations and regular time intervals.

The resulting data are used to assess the current state and spatial distribution of water quantity and quality, establish trends over time and evaluate the need for and effectiveness of water management measures. Usually, such assessments are appraisals of the current hydrological, morphological, physico-chemical, chemical, biological and/or microbiological conditions in relation to reference conditions, human effects and/or the existing or planned uses.

Given this understanding of assessments, the ultimate goal of monitoring is to provide the information needed to answer specific questions in decision-making. Monitoring stations may also provide early warning of possible deterioration of water quality and warnings of hydrological extreme events.

Monitoring of transboundary waters is part of the national monitoring network, which is regulated by national laws and regulations and international agreements. The legal and regulatory basis for monitoring and assessment, obligations from international agreements and other commitments should be carefully examined (chapter 2).

The river basin forms a natural unit for integrated water resources management. It is a natural unit in which rivers, lakes and groundwaters interact and which is linked – through coastal environments – with the oceans (Figure 1). Consequently, water assessments should be made and monitoring programmes should be designed for river basins.

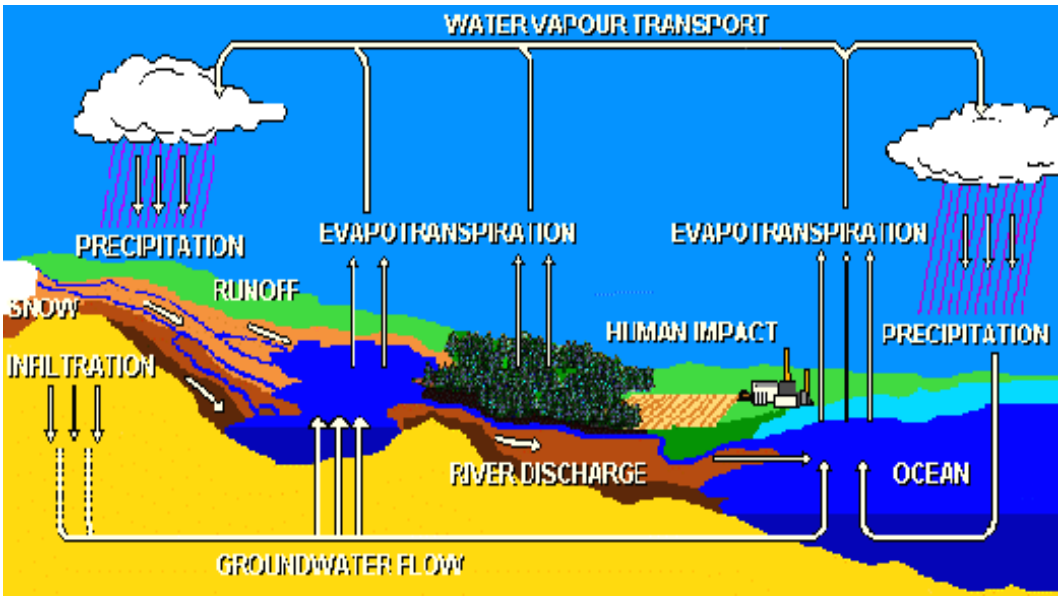

Figure 1. The key elements of the hydrological cycle of the river basin

The level of detail of monitoring and assessment depends on the density of the network, the frequency of measurements and observations, the size of the basin and/or the issue under investigation.

For example, when a measuring station at the outlet of the river basin reports water-quality changes, often a more detailed monitoring network is needed to reveal the source, the causal agent and the pathways of pollutants. The interaction between surface waters and groundwaters may also be different in the upper and lower parts of the river basin. In these cases, monitoring and assessments are usually made for the smaller, but entire, catchment areas of tributaries or lakes or the whole recharge areas of groundwater aquifers, whether transboundary or not.

Integrated water resources management also links social and economic development to the protection of natural ecosystems. The supporting information may need to be collected from multiple sources. For example, the data needed for assessment of the ecological state of a river, load calculations or estimates of the amount of groundwater drawn from an aquifer usually come from water management authorities/organizations. Additional information on land use and human activities come from other sources, such as population and economic statistics. In many instances, expert judgments and conceptual models of the river basin are also used.

As river basins usually stretch over different administrative units (e.g. States of a Federal Government, provinces), geographical units (e.g. mountainous and lowland areas) and political borders, cooperation between competent actors is needed. Such cooperative arrangements and institutional frameworks will largely influence the efficiency of monitoring and assessment (chapter 3). Carrying out monitoring and assessment of water quality and quantity requires adequate resources. Principles and approaches to funding and step-wise approaches to implement monitoring are essential and will be examined in chapters 4 and 5.

CHAPTER 2: LEGISLATION AND COMMITMENTS

Legislative acts may call for specific information to be provided through monitoring and assessment. Vice versa, monitoring and assessment results may be at the root of new legislation.

Moreover, decisions and/or recommendations of international meetings cause new requirements for monitoring and assessment. Examples include the World Summit for Sustainable Development with the Millennium Development Goals (MDGs) and governmental decision to set up and run monitoring and assessment programmes under the auspices of UN organizations, such as the Global Environmental Monitoring Programme (GEMS) and the Joint Monitoring Programme (JMP) (see section 2.3.2).

2.1 Relevant UNECE Conventions and Protocols

2.1.1 UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention)

The 1992 Water Convention[4] main goal is to prevent, control and reduce any transboundary impact, which includes significant adverse on human health and safety, flora, fauna, soil, air, water, climate, landscape and historical monuments or other physical structures. The Convention is one of the most essential legal instruments for the monitoring and assessment of transboundary waters (transboundary rivers, transboundary groundwaters, transboundary and international lakes) in the UNECE region. Several bilateral and multilateral agreements[5] among UNECE countries support action required by the Water Convention.

When defining and specifying information needs, establishing monitoring systems and making assessments on the status of transboundary waters, one should note that the Convention requires the

[4] http://www.unece.org/env/water/pdf/watercon.pdf
[5] http://www.unece.org/env/water/partnership/part.htm

setting of emission limits for discharges from point sources on the basis of the best available technology (BAT)[6]. It also requires authorizations for wastewater discharges and the application of at least biological or equivalent processes to treat municipal wastewater. The implementation of best environmental practices (BEP)[7] is needed to reduce the input of nutrients and hazardous substances from agriculture and other diffuse sources.

Joint bodies, i.e. any bilateral or multilateral commission or other appropriate institutional arrangements for cooperation between Riparian Parties have a specific role in monitoring and assessment under the Convention (see chapter 3).

2.1.2 Protocol on Water and Health to the 1992 Water Convention

Under the Protocol on Water and Health[8] effective systems for monitoring and assessing situations likely to result in outbreaks or incidents of water-related disease and for responding to them or preventing them should be established. This will include inventories of pollution sources, surveys on high-risk areas for microbiological contamination and toxic substances, and reporting on infectious and other water-related diseases. The Parties shall also develop integrated information systems to handle information about long-term trends in water and health, current concerns and past problems and successful solutions and the provision of such information to the authorities. Moreover, comprehensive national and/or local early-warning systems are to be established, improved or maintained.

2.1.3 Protocol on Civil Liability and Compensation for Damage caused by the Transboundary Effects of Industrial Accidents on Transboundary Waters (Civil Liability Protocol)

The Civil Liability Protocol[9] is a joint Protocol to the UNECE Water Convention and the Industrial Accidents Convention. It contains provisions on measures to reinstate or restore damaged or destroyed components of transboundary waters. For this purpose, it is important to know the conditions of the transboundary waters that would have existed had the industrial accident not occurred. This requires appropriate data and information on the status of transboundary waters and their components[10].

2.2 EU legislation

The legislation of the European Union is a major tool for defining how surface waters and groundwaters should be used, protected and restored. The two main approaches to prevent, control and reduce water pollution - the Water Quality Objective Approach and the Emission Limits Value Approach – play a decisive role in monitoring and assessing watercourses: The first approach sets the minimum quality requirements of waters and the second one the maximum allowed quantities of pollutants discharged to water courses.

Specific monitoring obligations result from several EU Directives, such as the Urban Waste Water Treatment Directive (1991)[11], the Integrated Pollution Prevention and Control Directive (1996)[12], the Nitrates (from Agricultural Sources) Directive (1991)[13], the Drinking Water Directive (1975)[14],

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[6] http://waste.eionet.eu.int/definitions/bat
[7] http://www.ospar.org/documents/ dbase/publications/p00023_BEP-E.pdf
[8] http://www.unece.org/env/documents/2000/wat/mp.wat.2000.1.e.pdf
[9] http://www.unece.org/env/civil-liability/welcome.html
[10] The term "components" was not defined under the Protocol; obviously it refers to fauna, flora, sediments, etc.
[11] http://europa.eu.int/eur-lex/en/consleg/main/1991/en_1991L0271_index.html
[12] europa.eu.int/eur-lex/en/consleg/ main/1996/en_1996L0061_index.html
[13] http://europa.eu.int/eur-lex/en/consleg/main/1991/en_1991L0676_index.html
[14] http://europa.eu.int/eur-lex/en/consleg/main/1975/en_1975L0440_index.html

the Bathing Water Quality Directive (1976)[15] and the Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (1976)[16]. The key directive concerning monitoring is, however, the Water Framework Directive, WFD[17] (2000, 2001[18]).

The Water Framework Directive (WFD) provides the framework for the protection of surface waters, transitional waters, coastal waters and groundwaters in the EU area. The main aims of the WFD are to prevent further deterioration and protect and enhance the status of aquatic ecosystems, promote sustainable water use, and mitigate the effects of floods and droughts. The environmental objective is to achieve good status, ecological and chemical, of water by 2015 at the latest.

Within a river basin where use of water may have transboundary effects, the requirements for the achievement of the environmental objectives established under this Directive, and in particular all programmes of measures, should be co-ordinated for the whole river basin. For river basins extending beyond the boundaries of the Community, Member States should endeavour to ensure the appropriate co-ordination with the relevant non-member States. This Directive is to contribute to the implementation of Community obligations under international conventions on water protection and management, notably the UNECE on the protection and use of transboundary water courses and international lakes, approved by Council Decision 95/308/EC(15)[19] and any succeeding agreements on its application.

The surface water monitoring network of ecological and chemical status shall be established to provide a coherent and comprehensive overview of ecological and chemical status within each river basin and shall permit classification of water bodies into five classes.

In order to address the challenges in a co-operative and coordinated way, the Member States, Norway and the European Commission agreed on a Common Implementation Strategy for the Water Framework Directive. In the first phase of the joint process, a number of guidance documents (including monitoring, as well as public participation)[20] were prepared.

2.3 Other international agreements and practices

2.3.1 Legal obligations

Legal obligations on monitoring and assessment of watercourses arise from other international legal instruments, such as the Ramsar Convention on Wetlands (1971)[21], the Convention on Biodiversity (1992)[22] and the Convention to Combat Desertification (1994)[23], the Aarhus Convention (1998)[24], the Barcelona Convention (1977)[25], Regional Seas Conventions[26], and the Industrial Accidents Convention (1992).[27]

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[15] http://europa.eu.int/eur-lex/en/consleg/main/1976/en_1976L0160_index.html
[16] http://europa.eu.int/eur-lex/en/consleg/main/1976/en_1976L0464_index.html
[17] http://europa.eu.int/eur-lex/pri/en/oj/dat/2000/l_327/l_32720001222en00010072.pdf
[18] http://europa.eu.int/eur-lex/pri/en/oj/dat/2001/l_331/l_33120011215en00010005.pdf
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[20] http://europa.eu.int/comm/environment/water/water-framework/guidance_documents.html
[21] www.ramsar.org/key_conv_e.htm
[22] www.biodiv.org/convention/articles.asp
[23] http://www.unccd.int/main.php
[24] www.unece.org/env/pp/documents/cep43e.pdf
[25] http://europa.eu.int/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&lg=en&numdoc=21976A0216(01)&model=guichett
[26] www.greenyearbook.org/agree/mar-env/regseas.htm
[27] www.unece.org/env/teia/welcome.html

The Statistical Office of the European Communities (Eurostat) provides statistics on water resources, water abstraction and use, and wastewater treatment and discharges through the Eurostat/OECD Joint Questionnaire[28]. The data is collected in Member States by their statistical authorities, and include monitoring data from watercourses.

2.3.2 Benefit of international programmes

One of the most important sources of information on the status of rivers, lakes and groundwater aquifers is the EUROWATERNET[29], which has been created by European Environment Agency (EEA). It s being further developed to comply with the recommendations on the strengthening of national and transboundary environmental monitoring and information systems in countries of Eastern Europe, the Caucasus and Central Asia. [30, 31]

Monitoring and assessment activities under the auspices of the UN produce important information, which can be used for the purpose of assessments of transboundary watercourses. The GEMS/Water Programme[32], for example, is a primary source for global water quality data, and provides information on the state and trends of regional and global water quality. The Global International Waters Assessment (GIWA)[33] produces a comprehensive and integrated global assessment of international waters, the ecological status of and the causes of environmental problems.

The World Water Assessment Programme[34] seeks to develop the tools and skills needed to achieve a better understanding of the basic processes, management practices and policies that will help improve the supply and quality of global freshwater resources. Its product – the World Water Development Report - is a valuable source of information on the state of water resources in countries and regions.

For data and information on groundwaters, the International Shared Aquifer Resources Management (ISARM)[35] should be consulted, which aims at developing methods and techniques for improving the understanding the management of shared groundwater systems, considering both technical and institutional aspects. The International Groundwater Resources Assessment Centre (IGRAC)[36] that facilitates and promotes worldwide exchange of groundwater knowledge to improve assessment, development and management of groundwater resources is another important source of information on groundwater issues.

The National Hydrological/Meteorological Services of WMO Member States operate over 475,000 hydrological stations worldwide. The respective national databases should be consulted if seeking for water quantity data and related information. Another important source of data is provided the Global Runoff Data Centre (GRDC). It is the digital worldwide depository of discharge data and associated metadata. GRDC's role is to serve as a facilitator between data providers and data users. It works under the auspices of the World Meteorological Organization and has been established at the German Federal Institute of Hydrology as early as 1988 in order to support the hydrological and

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[28] http://www.eurostat.org/
[29] reports.eea.eu.int/TECH07/en/tab_abstract_RLR
[30] www.unece.org/env/documents/ 2003/ece/cep/ece.cep.94.rev.1.e.pdf
[31] www.unece.org/pub_cat/topics/env.htm (ISBN 92-1-116848-1)
[32] www.gemswater.org/
[33] http://www.giwa.net/giwafact/giwa_in_brief.phtml
[34] www.unesco.org/water/wwap/
[35] www.iah.org/isarm/
[36] www.igrac.nl/
www.wmo.org

climatological research community by collection and dissemination of a comprehensive and sound runoff database.

Data on water-related disease can be accessed through the WHO Health for All Database.[37] It includes data on diarrhoeal diseases (population under 5 years; per 100,000 inhabitants); viral hepatitis incidence per 100,000 inhabitants; viral hepatitis A per 100,000 population; malaria incidence per 100,000 population; percent of population whose homes are connected to a water supply system; and percent of population having access to sewage system, septic tank or other hygienic sewage disposal. Supporting data is available from the Joint Monitoring Programme (JMP), carried out jointly by WHO and UNICEF. The goals of the JMP are to report on the status of water-supply and sanitation, and to support countries in their efforts to monitor this sector, which will enable better planning and management. It should be emphasized that due to poor reporting commitments of some countries in the UNECE region, the data availability in the Health for All database and the JMP is insufficient.

CHAPTER 3: ESTABLISHING THE INSTITUTIONAL FRAMEWORK

3.1 Institutional arrangements at the national level

A lack of suitable institutional arrangements for monitoring and assessment at national and local level may hamper international cooperation. In particular, responsibility for surface water and groundwater management, both regarding water quality and quantity, may reside in several different organizations. It is essential, therefore, to ensure at least cooperation between the various national and local government organizations for the development and implementation of joint activities between riparian countries and adapt, if need be, the national legislation.

3.2 Institutional arrangements at the transboundary level

According to the Water Convention, riparian countries should set up joint bodies, where these do not yet exist, and include monitoring and assessment of transboundary surface and groundwaters in the activities of these joint bodies. Riparian countries may decide to establish a specific working group under the joint body, which is responsible for defining and implementing the monitoring and assessment, including its technical, financial and organizational aspects.

Riparian countries should, through their respective joint bodies, establish close cooperation 'across the border' between authorities dealing with land-use planning and development and the rational use and the protection of water at the early stages of the planning process and at all levels of Government. This will help to overcome conflicting interests in sectoral planning both in the national and in the transboundary contexts.

3.3 Institutional arrangements related to quality systems

A quality system is essential to ensure the reliability of information obtained by monitoring and that the results will satisfy the users. The quality system should be organized around all the elements of the assessment cycle, starting with procedures for specification of information needs and developing a monitoring strategy, through (existing ISO and other) standards for sample collection, transport and storage, laboratory analysis, and data validation, storage and exchange, to Data Analysis Protocols and reporting protocols[38].

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[37] http://www.euro.who.int/hfadb

[38] Also see Quality Assurance river guidelines background report on IWAC website

Riparian countries should, where appropriate, assign to their joint bodies responsibilities related to quality systems. Cooperation on the local level for carrying out monitoring practices should be encouraged and promoted including direct contacts between laboratories and institutions involved.

Regarding laboratory quality systems, the trend through the broader analytical community is to strengthen laboratory QA from simple internal quality control measures, to laboratory accreditation, to international standards such as ISO/IEC 17025, (formerly ISO Guide 25 & EN45001), General Requirements for the Competence of Calibration and Testing Laboratories[39]. The use of documented analytical methods is also integral to the generation of reliable water quality data. A lack of such documentation can lead to the production, merging and comparison of water quality data generated by different procedures for the same variable[40].

3.4 Frameworks on access to and exchange of information

Following provisions of the Water Convention and the Aarhus Convention [28], riparian countries should give each other access to relevant information on surface water and groundwater quality and quantity. To be effective, arrangements for the exchange of information among riparian countries and arrangements for the provision of information to the public should be governed by rules jointly agreed by the riparian countries. These arrangements should specify the format and frequency of reporting. No charge should be made for the exchange of available information. The creation and maintenance of a joint database within joint bodies proves to be useful.

CHAPTER 4: PRINCIPLES AND APPROACHES TO FUNDING

Carrying out monitoring and assessment of water quality and quantity requires adequate resources. Monitoring and assessment programmes have to compete with other activities for limited funds. Therefore, those who carry out monitoring and assessment need to be able to make a funding case that sets out both the benefits of monitoring for management of water resources and water quality, and the possible costs in environmental degradation and other impacts of not monitoring.

The costs of monitoring should be estimated as accurately as possible before the start of monitoring programmes or when major revisions are planned. If the information needs are well-defined, this is an exercise that can be performed in a rather detailed and precise manner. The monitoring costs can be divided into the following components (Table 1):

- Administration of the network, including design and revision;
- Capital costs of monitoring and sampling equipment, construction of observation boreholes or surface water sampling sites and gauging stations, transport, data processing hardware and software;
- Labour and other operating costs of sample collection and field analysis;
- Labour and other operating costs of laboratory analyses;
- Labour costs of data processing, interpretation, reporting and production of outputs;
- Maintenance costs of field and laboratory equipments.

[39] www.fasor.com/iso25/
[40] UNEP GEMS/Water, IAEA. 2004. Analytical Method for Environmental Water Quality
[28] www.unece.org/env/pp/documents/cep43e.pdf

Table 1. Influence of monitoring components on costs

Cost component	Sampling points		Sampling Frequency	Choice of determinands
	Type	Density		
Administration of network	+	+	+	+
Capital for equipment	++	++	+	++[1]
Operational costs of sampling	+	++	+++	++[2]
Operational costs of analysis	+	+++	+++	+++
Data processing	+	++	++	++
Assessment and reporting	+	+	+	+

Notes: +++ major influence ++ some influence + little influence
[1]may have influence on the instrumentation required in the laboratory
[2]introduction of field analysis of unstable determinands increases sampling costs

The costs associated with administration as well as assessment and reporting are largely fixed and more or less independent of the extent of the network.

In contrast, the costs of other activities are strongly controlled by the number and types of sampling points, their complexity, frequency of sampling and the range of determinands to be analysed. The number of sampling points can be multiplied with frequency and determinands to obtain rough estimates of costs. A simple spreadsheet can be used in the planning stage to test the sensitivity of monitoring costs to various options of frequency, density and determinands, and to see where new resources are required.

Because of the long-term, continuous character of monitoring, a long-term commitment to funding is crucial. This means that funding should come mainly from the State Budget. Water users, such as municipalities, water and waste utilities, factories, farmers or irrigators, could also contribute to the funding of the programmes and it may be possible to raise funds by using part of the income from licensing water use or by invoking the "polluter-pays"-principle.

Monitoring and assessment programmes for transboundary waters should be established within national monitoring programmes of the riparian countries, which take responsibility for all the costs on their own territory. The riparian countries should decide together on funding principles and make clear agreements for the funding of specific joint tasks.

CHAPTER 5: DEVELOPING STEP-BY-STEP APPROACHES

5.1 Alternative step-by-step approaches

Monitoring and assessment of transboundary waters generally have multiple objectives (see chapter 1). To make the best use of available resources, a step-by-step or phased approach is recommended, especially where funds are limited (see chapter 4).

A step-by-step approach entails identifying and agreeing on priorities for monitoring and assessment and progressively proceeding from general appraisal to more precise assessments and from labour-intensive methods to higher technology ones. In many cases, the lack of appropriate, consistent and reliable data and the absence of an adequate picture of baseline status against which the new monitoring data can be compared make a step-by-step approach the most realistic. There are several alternatives for developing a step-by-step approach in a transboundary context.

One alternative is, for example, to start with informal cooperation at an operational level of mutual trust, lead to more formal agreements and establishment of joint bodies. Experience suggests that it could involve starting with modest objectives i.e. with regular exchange of data and information about the sampling methods and instrumentation used and leading to commonly agreed measurement, sampling procedures and analytical methodologies, for paving the road to joint measurements and sampling. Eventually, the target would be joint data analysis and regular joint assessments, backed up by joint monitoring design.

Another alternative of a step-by-step approach is to start surface water monitoring and then extending it to groundwaters, or vice versa, depending on the relative importance of these waters in the transboundary basin.

Taking a step-by-step approach could also mean starting with data exchange for stations and sampling points close to the border and then, once well established, extending it to the whole transboundary basin or aquifer.

Finally, a step-by-step approach might mean starting with the exchange of information on water status (quality and quantity) and then, as the relationship between riparian countries becomes stronger, sharing information on pressures and driving forces; evaluating the impacts on the main water uses and considering possible responses, i.e. applying the DPSIR framework. Responses could include management measures to control, reduce or reverse the impacts, and additional monitoring and assessment to see whether these measures are effective.

5.2 Prioritizing monitoring efforts

Identification of the main water management issues helps considerably in prioritizing information needs and monitoring activities. Thus, the use of the DPSIR framework (see Figure 4) and the functions and issues matrix (Table 2) at an early stage of the assessment process will have identified the most important information needs for water quality/quantity, and the relevant parameters requiring monitoring.

Thus, a relatively small transboundary basin in a sparsely populated rural area may have few water uses and hardly any threats to water quality or quantity. In other, larger and more densely populated basins there may be significant water use and many pressures and potential threats.

National surveys and land-use maps can provide a rapid overview of possible pressures in the basin. The risks to the various uses and to the health of the population need to be taken into account in prioritizing monitoring between surface water and groundwater. By using risk assessment techniques (and recording how they were undertaken), those responsible for assessments can decide which monitoring activities have the highest priority. This could be quantified using the concept of expected damage, i.e. what goes wrong when there is insufficient information because of lack of monitoring? What losses occur when less than optimal decisions are made as a result?

No monitoring programme can measure all the variables, at as many sites and as frequently as would be desirable. Therefore, within the monitoring design, risk-based approaches should also be

used for the selection of variables. For many variables, existing literature on their occurrence in the environment and in particular in freshwater systems can provide guidance in prioritization. Based on their physico-chemical properties, predictions can be made as to which chemicals are most likely to reach surface water and groundwater. If there is sufficient information for predictions of concentrations to be made, these can be compared with environmental or health standards and expected harmful effects, to further prioritize parameter selection.

In the case of groundwater, the long-established and widely adopted approach of defining and mapping the vulnerability of aquifers to pollution can be used to prioritize monitoring. Based on the physical and chemical properties of the soil and the geological materials above the water table, the potential for pollutants to be retarded and attenuated is evaluated and mapped. Where such maps exist, they can be used to help focus monitoring in areas where groundwater has important uses and where it is most vulnerable.

Risk assessment can also be used to determine whether the chosen monitoring strategy will fully meet the information needs. Statistical modeling to help optimize monitoring design (spatial density and sampling frequency) implies an element of risk analysis; if either density or frequency are reduced, will the resulting decreased level of information still be adequate for all (or enough) of the information needs already specified?

5.3 Using pilot projects

Pilot projects have played an important role in demonstrating the use of the UNECE guidelines on monitoring and assessment of transboundary waters[45]. Such pilot projects on river basins or portions of river basins, lakes and groundwaters can play an important role in implementing the monitoring obligations under the Water Convention. They can help to establish effective and efficient (tailor-made) monitoring and assessment programmes, sustainable in the specific economic context of the countries concerned. Furthermore, pilot projects can help to initiate bilateral and multilateral cooperation, leading to institutional strengthening and capacity building.

One important lesson learned from pilot projects is that they require considerable commitment and effort to get them started, and take much longer to complete than usually envisaged. The reasons for this include differences in institutional frameworks and responsibilities at national and local levels, legal obligations (EU and non-EU neighbours), economic conditions and financial and human resources between riparian partners.

Given the various alternatives of step-by-step approaches (see section 5.1) it is however strongly recommended to implement pilot projects in the first instance, before setting up tailor-made monitoring and assessment systems for all the riparian countries' transboundary waters. The advantage of such an approach is that many organisations with a direct or indirect stake in the use and management of transboundary waters will alreday be involved in pilot projects, for some them the concepts of transboundary monitoring and assessment are new and challenging. Pilot projects have achievable objectives and clear and realistic tasks, which are sufficiently flexible to take account of the specific characteristics of the basin, lake or aquifer. These characteristics include the number of riparien countries and their proportions in the basin, the political, social, institutional and economic situation of these countries and the physical nature of the basin itself.

CHAPTER 6: IMPLEMENTING MONITORING PROGRAMMES

Monitoring and assessment of watercourses, including transboundary rivers, lakes and groundwaters, follow a certain sequence of activities, which can be best demonstrated through the "monitoring and assessment cycle" in Figure 2. The following chapters dwell on each of the shown activities.

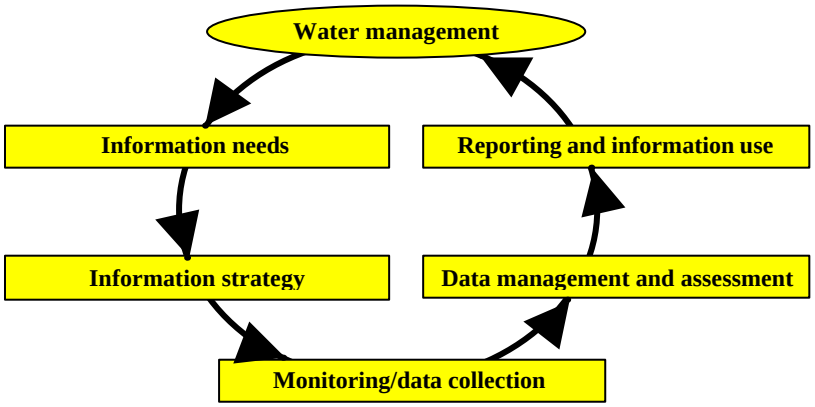


Figure 2. Monitoring and assessment cycle

In a river basin, various functions and uses may compete or even conflict, in particular if water is scarce or its quality deteriorating. Examples include:

- The competition for water within a country (e.g. water use for drinking, recreation, industry and agriculture);
- Different upstream-downstream interests of riparian countries (e.g. hydropower production in an upstream country and irrigational water use in a downstream country).

When analyzing water management issues, political priorities should be made clear. The analysis of sources of conflicts is a precondition for the setting of priorities. In general, three steps must be considered: As the first step, all functions indicating the use or the importance of a certain watercourse must be listed (see Table 2), defined and prioritized. Prioritization is especially important for those countries where basic needs, like the supply of wholesome drinking water are so urgent that other uses will have lower priority. Secondly, functions must be designated to specific watercourses. And thirdly, water-quality objectives or even environmental quality objectives need to be considered, taking into account the functions as such and/or the specific characteristics of the watercourse concerned.

Table 2. Examples of relations between functions/uses and issues of a river basin

FUNCTIONS/USES → ISSUES ↓	Human health and safety	Ecosystem functioning	Fisheries	Recreation	Drinking water	Irrigation	Industrial use	Hydro power	Transport medium[1]	Navigation
Flooding	X	x		x					x	x
Scarcity	X	x	x	x	x	x	x	x	x	x
Erosion / sedimentation	X	x			x			x	x	x
Biodiversity loss		x	x	x						
River continuity decrease		x	x	x				x	x	x
Salinisation		x			x	x	x			
Acidification[2]		x	x		x					
Organic pollution[3]	X	x	x	x	x					
Eutrophication	X	x	x	x	x	x	x			
Pollution with hazardous substances[4]	X	x	x	x	x	x	x			

x Main impact on functions/uses (problem).

[1] Transport of water, ice, sediments and waste-water.

[2] Dry/wet acid deposition

[3] Organic matter and bacteriological pollution by waste-water discharge

[4] Specific substances, e.g. radio-nuclides, heavy metals, pesticides.

6.1 Information needs

The most critical step in developing a successful, tailor-made and cost-effective monitoring programme is the identification and, thereafter, the specification of information needs. Information needs means a precise question on which information has to be provided within a certain context. To properly design and operate the monitoring and assessment system, information needs should be written off as specific as possible.

6.1.1 Identification of information needs

The analysis of the water management of the river basin and the identification of the issues are the basis for specifying the information needs (see Table 2). A distinction should be made between information used for policy preparation and/or evaluation, and information used in operational water management. To specify information needs, the functions and uses of the basin should be known, as it is the case with targets and target dates for policy implementation. One should also have knowledge about the state of the watercourse and about factors in the basin that can affect such a state. Moreover, the requirements of national legislation and international agreements (see chapter 2) should be known. If such information is not available, relevant survey should be undertaken to seek for missing data and information (see Figure 3)

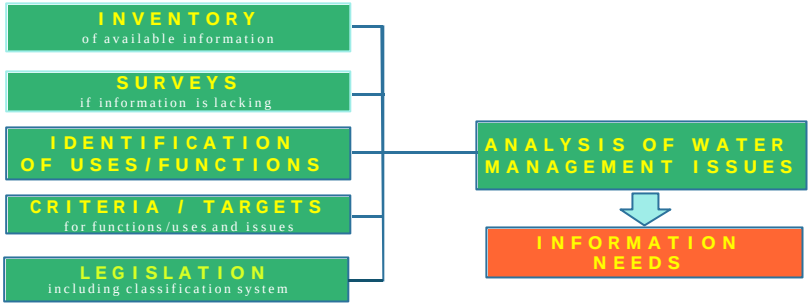


Figure 3. Water management analysis

6.1.1.1 Inventories

Inventories should bring together the information that is available, but often incoherent and distributed among different agencies/institutions or their various departments. This includes not only the listing of information available from historical data, licenses, etc. in administrative databases, but also a general screening and interpretation of all information relevant to the aspects under consideration. For inventories of pollution sources, this implies looking for the source of information, e.g. production processes, use of raw materials, and verification of suspicion by additional questioning.

Inventories should cover the major aspects that are relevant to the identification of the issues. These include for example: water uses and water needs in the river basin; run-off characteristics and the probability of flood waves and ice drifts in the river basin; groundwater level declines, water quality (not only physico-chemical, but also sanitary, biological, ecological and ecotoxicological); the most important point sources of pollution from industry and municipal waste, characterising these in terms of production process, pollution composition and discharge load; land uses and diffuse pollution sources from land use, with an inventory of the use of fertilisers and pesticides in agriculture; other sources of diffuse pollution may include traffic, pipelines, airborne pollution; potential sources of accidental pollution; existing point pollution sources (e.g. uncontrolled waste disposal sites).

6.1.1.2 Surveys and hot spots analysis

In addition, surveys are needed if insufficient data are available from the inventory to identify an issue and to specify what monitoring is needed. Surveys could be related to a broad range of subjects, such as the evaluation of site conditions (e.g. post-flood surveys), the variability of monitoring characteristics in space and time, or the screening of the occurrence of pollutants or toxic effects in water and sediments.

Water-quality surveys are intended to give a first insight into the functioning of the aquatic ecosystem and the occurrence of pollution and toxic effects in the water. By investigating qualitative and quantitative structure of biocoenose concerned (the phytoplankton, the macrophytes, the macro-invertebrate community, fishes) the ecological status of a river, lake or estuary can be assessed. Chemical screening of surface water, groundwater, sediment and effluents at hot spots and key locations can be performed with relevant supporting analyses. Additionally, specific target compounds that might be expected according to the inventory can be analysed. Toxic effects in surface water, sediments and effluents can be investigated at these locations.

Hot spots in surface water, groundwaters, effluents and sediments should be identified through preliminary investigations. Inventories of available information from effluent discharges and monitoring data will give a first indication of where a combination of toxic effects is to be expected. The 'hot spots' can be characterised with the detailed chemical, ecotoxicological and biological data from additional in-depth surveys.

6.1.2 Involvement of the right institutions and people

The institutions responsible for the protection and use of the transboundary watercourses, especially joint bodies, should be involved in the process of specifying information needs. Both information users and information producers should be identified first.

6.1.3 Specification of information needs

Information needs should be further specified, to be able to design a monitoring and assessment system. It should be kept in mind that monitoring is not the only source of information; often a combination of sources has to be used to meet the information needs.

To be able to develop a monitoring network from the information needs, the specified information needs should include the following items:

- The selection of appropriate parameters and/or indicators. They should properly reflect a specific information need;
- The definition of criteria for assessment, e.g. considerations for the setting of standards or criteria for the choice of alarm conditions for early warning in the event of floods or accidental pollution;
- Requirements for reporting and presentation of the information should be specified (e.g. visualization, degree of aggregation, indices);
- Relevant margins have to be specified for each monitoring parameter, e.g. on the detail which is relevant for decision-making. A relevant margin could be defined as the information margin that the information user is concerned about;
- The response time should be specified. The response time is the period within which the information is needed. In early-warning procedures, information is needed within hours, whereas for trend detection information is needed within weeks or even months after sampling;
- It has to be decided what degree of reliability is required. To what extent is false information allowed? 100% reliability is impossible or prohibitively expensive. Depending on the consequences, information should be more or less reliable. Together with the relevant margin, this is a determining factor when locations, frequencies and methodologies are chosen in the design of monitoring programmes.

6.1.4 Prioritization of information needs

As information needs are derived from issues, the prioritization of issues consequently leads to a prioritization of information needs. Information is mostly needed on high-priority issues. If the same information need arises from various issues, this information need should be given high priority, because by collecting this information once, a variety of issues is addressed (also see chapter 5).

6.1.5 Indicators and the DPSIR-framework

Information should preferably be presented in a condensed/aggregated way (chapter 8). Information should be comparable between places and situations, and it should be linked to specific issues, which - in turn – are based on specific management needs. Indicators may provide for this and, in this respect, indicators also may facilitate the identification of information needs.

The selection of an indicator is a means of reducing the volume of data without loosing significant information. Indicators are preferably measurable parameters. Such a parameter is influenced by the water's conditions (physical, chemical, biological, etc.) and accurately reflects these conditions for a specific issue. As it represents an environmental process, it is also significant for the overall ecological functioning of the water. Also, they should be suitable for communicating to policy makers or to the public. As an example for eutrophication, total phosphorus can be a good indicator of the status of the river.

To identify suitable indicators, appropriate variables have to be selected. These variables should sufficiently represent functions and uses of water bodies, characterize water quantity or quality, characterize an effect on a function or use, characterize the pollutant discharge, and/or be of value for testing the effectiveness of measures. Riparian countries should agree on the choice of indicators.

Usually, information needs are identified and specified for different parts of the DPSIR framework (Figure 4) the causal framework for describing the interactions between society and the environment, which was drawn up and adopted by the European Environment Agency (EEA). Examples of Driving Forces are the sources of a problem, such as households or agriculture, and the way they create the problem, such as the generation of wastewater or the use of fertilisers. The resulting Pressures may be the wastewater that flows into the surface water, treated or untreated, or the amount of nutrients that runs off from the land into the surface water or seeps into the groundwater. The State of the surface or groundwater is then depicted by concentrations of nutrients or organic matter. The Impact can be seen in changes of biodiversity or changes in use, such as a drinking water company that has to apply extra treatment. The societal Response finally is the policies and measures taken.

A Response aiming at Driving Forces is, for instance, the promotion of best agricultural practices. Aiming at Pressures, the use of improved wastewater treatment may be a good response. An example of a response to change the State is the application of calcium to fight acidification of lakes. A response related to Impact is, for instance, active fishing of specific fish species that maintain turbidity of the water by stirring up sediments. Indicators should be chosen so as to reflect each of the DPSIR components.

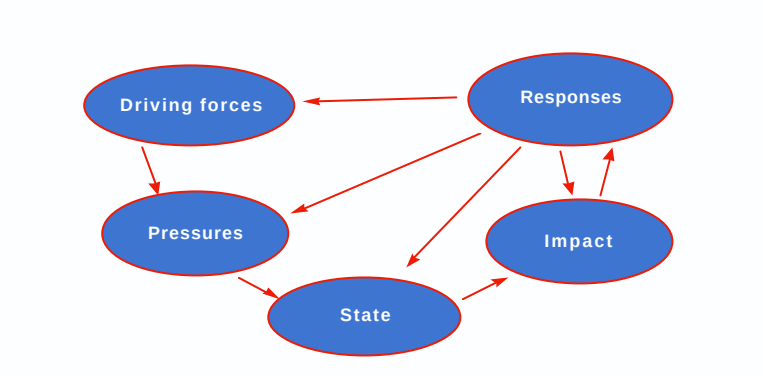


Figure 4: The Driving Forces-Pressures-State-Impact-Responses (DPSIR) framework (EEA)[41]

Important criteria for choosing an indicator:

- **Communication**: the indicator should be appealing to those who will use it in all riparian countries;
- **Simplification**: the indicator should provide insight into the situation, without giving much detail. A low oxygen concentration in a river, for instance, indicates that the situation is not good. A high oxygen concentration situation indicates good potential;
- **Availability of data:** if few or no data for the indicator can be made available, its information content may be too low.

6.2 Information strategy

After the specification of information needs, an information strategy is developed, which defines the best practical way and means to gather data from various sources: from the monitoring network, from expert judgments, from statistical publications and the bookshelf of various institutions. Although monitoring is essential, it is only one of the many possibilities to gather data on disciplines such as agriculture, recreation, sociology, ecology and economics. Often local governments and municipalities are able to provide data on water purification and sewage utilities, factories, farmers or irrigators. The results of self-monitoring, i.e. monitoring of effluents and wastewater discharges by industries or municipalities, often under the conditions of their discharge license, is an valuable additional source for transboundary water assessments.
Thus, the information strategy should culminate in a monitoring plan and a plan for gathering data from other sources.
To this end, models are essential. They can be used to screen alternative information strategies, optimize network design and assess the effectiveness of proposed measures. In any case, models should be carefully calibrated and validated with historical data to avoid unreliable results and erroneous decisions regarding in the information strategy or the interpretation of the behaviour of the river basin or aquifer.

6.3 Monitoring/Data collection

The information strategy defines what part of the information is collected through a monitoring system, and the information needs analysis (see section 6.2) provides the appropriate parameters, assessment criteria, relevant margin and response time, from which the monitoring programme can be designed and implemented.

[41] org.eea.eu.int/documents/brochure2002/approach.html

6.3.1 Monitoring objectives

The main monitoring objectives for effluents, rivers, lakes and aquifers are to generate information for:

- Assessing the actual status of a watercourse;
- Testing for compliance against permits for water withdrawal or discharges of waste water, or for setting levies;
- Verifying the effectiveness of policy measures, by indicating the degree of implementation of measures, by detecting long-term trends in water levels, concentrations and loads, and by demonstrating to what extent the intended targets were reached;
- Providing early warning to protect the intended water uses in the event of flooding or accidental pollution;
- Recognizing and understanding water-quantity and water-quality issues, erosion patterns or biological processes.

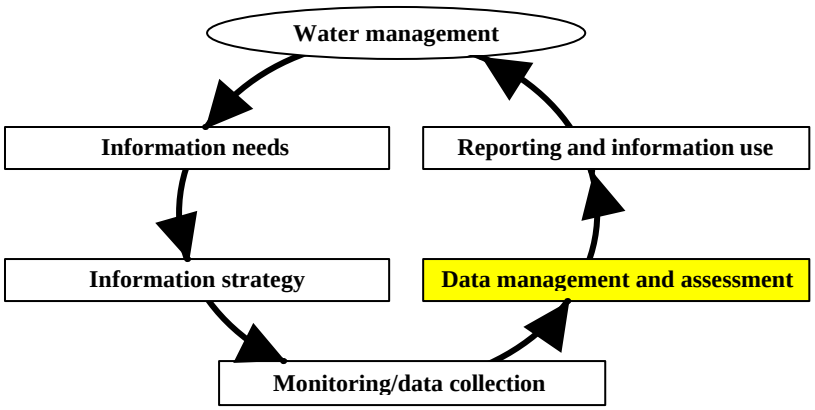
6.3.2 Continuity in monitoring and revision of programmes

Information needs change as water management develops, targets are attained or policies changed. Consequently, information strategies need to be adapted over time; this will also have an impact on monitoring and data collection.

Generally, after three years of measurements/observations and data evaluation, the various steps of the monitoring and assessment cycle are re-evaluated. Feedback from the outcome of assessments is applied to re-design monitoring networks. However, one should recognize that there is a need for continuity (in parameter, location, analytical method, etc.) to produce time series quantity and quality data. Continuity is also necessary to detect significant and reliable trends in river-basin characteristics. Environmental monitoring programmes should always be seen as requiring long-term commitment.

CHAPTER 7: MANAGING DATA AND MAKING ASSESSMENTS

The goal of the data management component of the cycle is to convert the data into information to meet the already-specified information needs and the associated objectives of the monitoring programme. The combined use of data from multiple sources places high demands on systems of data exchange and data management.



7.1 Data management

To safeguard the future uses of the data that have been collected, several steps in data management are required before information can be properly used:

- Collected data should be validated and approved before being made accessible to users or entered into a data archive;
- Data should be analyzed, interpreted and converted into well defined information using appropriate data analysis techniques;
- Information should be reported to those who need to use it for decision-making, model validation, management evaluation or in-depth investigations. The information may need to be presented in tailor-made formats for different users or target groups (GIS maps, time series, bar charts, summary reports).
- Data and information should be stored for future use and data exchange should be facilitated at the level of the institutions undertaking the monitoring and assessment, and also at international, joint body, national, local government, river basin or aquifer levels as appropriate.

Within these data management steps, storage probably remains the weakest point of all.

7.1.1 Developing a data dictionary

Transboundary cooperation will involve the exchange of data. The first steps in archiving monitoring data are usually taken at the monitoring agency itself. To facilitate the comparability of data, clear agreements should be made between the neighbouring countries on the coding of data and meta-information.

Consideration should be given to standardizing the software packages for data management and data storage formats to help data exchange. Furthermore, agreements regarding the availability and distribution of data may facilitate their exchange. A data dictionary containing this information and agreements on the definition of terms used for exchange of information or data should be prepared and agreed.

7.1.2 Data validation

Data validation is an intrinsic part of data management.

Data validation includes regular checking and control of newly produced data (detection of outliers, missing values and other obvious mistakes). There are computer programmes available to perform various control functions, including correlation analysis and application of limit pairs, and to help detect outliers. However, expert judgment and local knowledge of the surface water and groundwater systems are also indispensable for validation.

When the data have been thoroughly checked and any necessary corrections or additions made, they can be approved and made accessible.

7.1.3 Data storage and meta-information

To be available for future use, data should be stored so that they are accessible and complete with respect to all of the conditions and qualifiers (such as detection limits) pertaining to the data collection and analysis. The dimensions and units should always be included. Furthermore, a sufficient amount of extra data (‘meta-information’) necessary for interpretation and reporting

should also be stored. These include such characteristics as the date, location and depth of measurement or sampling, type of sample and type of measurement or sampling installation, any preconditioning procedures and analytical technique.

If the monitoring is performed in media other than the water phase (e.g. suspended solids, biota), relevant information, such as the total amount of substances held in the different media or particle size distribution should be recorded and stored.

The database should have safeguards against the entering of data without adequate meta-information.

7.1.4 Managing data from multiple sources

Both the management of monitoring datasets with the associated meta-information and the management of supporting information needed for interpretation and collected from several sources and different institutions require the use of computers and suitable software.

In particular, the use of relational databases, spreadsheets and linked geographic information systems (GIS) will allow the integrated interpretation of data with supporting information such as maps, land use, satellite imagery for water quantity and quality assessment and in relation cases of pollution accidents and flooding. Such systems allow the use of simulation models, controlled access of a broad range of information users, and adaptation of reporting to the needs of the users. Managing and integrating data from different sources and institutions into one system is not easy. The databases should be harmonized only to the extent necessary, but at least compatible interfaces should be used to interconnect them with a GIS (Figure 5).

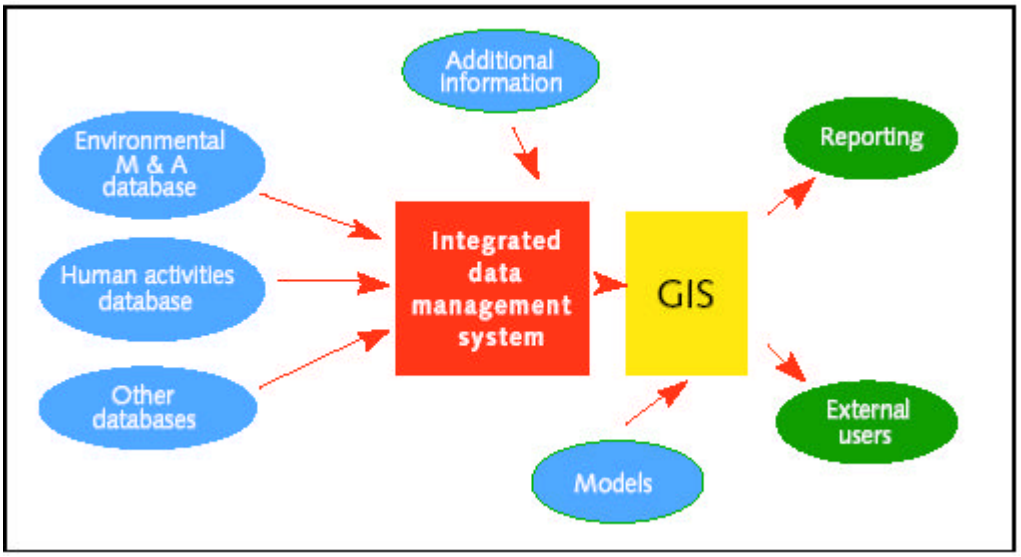


Figure 5. Integrated environmental information system

7.1.5 Data exchange

There is a need for an agreed format for the exchange of digital data. The data dictionary referred to above should be the basis for the definition of such a format. The data storage systems in the neighbouring countries need to be able to handle the agreed data exchange format and allow the data to be imported into modeling or statistical packages.

For storage of data on transboundary watercourse, the relevant joint body may consider the establishment of a central system. The guidelines for data exchange developed by EUROWATERNET may be suitable for supporting such activities.[42]

7.1.6 Data analysis and interpretation

The conversion of data to information involves analysis and interpretation. Data analysis should be embedded in a Data Analysis Protocol (DAP), which clearly defines a data analysis strategy and takes into account the specific characteristics of the data concerned, such as missing data, outliers, non-normality and serial correlation. The adoption of DAPs provides the data-gathering organization, national institutions or joint bodies with certain flexibility in their data analysis procedures, but requires that these procedures should be properly documented.

Data will generally be stored in digital formats in computer systems and the analysis may be largely a statistical operation or set of operations using generic software packages. To achieve standard and automated data analysis, the use of tailor-made adaptations to the software may be desirable. A DAP should comprise procedures for processing the monitoring data to meet the specific interpretation needs (for example, calculations based on individual measurements or yearly averages, single sites or averages for the whole water course).

The DAP should be extended to reporting formats for the resulting information. A reporting protocol can help to define the different characteristics for each use or audience. The DAP should lay down the format of the report, the frequency of publication, the intended audience, distribution procedures, and the types of conclusions to be drawn and represented.

Statistical techniques may also be used to remove non-relevant deterministic influences. Such procedures should also include accepted methods for detection of trends and trend reversals, testing for compliance with standards, load estimations and calculation of quality indices.

7.2 Assessment methodology

The assessment methodology will in fact determine or at least influence the design of the monitoring programme. Therefore, it should be drawn up in parallel with undertaking an analysis of information needs and designing the monitoring programme.

Given the purposes of assessments (see chapter 1), a simple way of using monitoring results is based on certain key variables. Especially in cases, where binding water protection targets for certain pollutants, like pesticides, have been expressed by numerical norms or standards, a comparison of the watercourses state with standards is a straightforward task and could already be made in a very early phase. Also monitoring results of indicators are easy to assess. For example, for chlorophyll *a* - an indicator to estimate eutrophication - a comparison of the monitoring results with the values in the relevant literature or eutrophication classification schemes is a simple assessment method.

Another simple yet informative way of an assessment is to prepare maps of the distribution of the monitored determinands for certain larger water areas. Such an assessment is particular appealing and understandable for ordinary people.

In monitoring programmes, where large amounts of different data are collected continuously over several years, statistical methods are needed to effectively summarize the results of monitoring.

[42] http://dd.eionet.eu.int/index.jsp

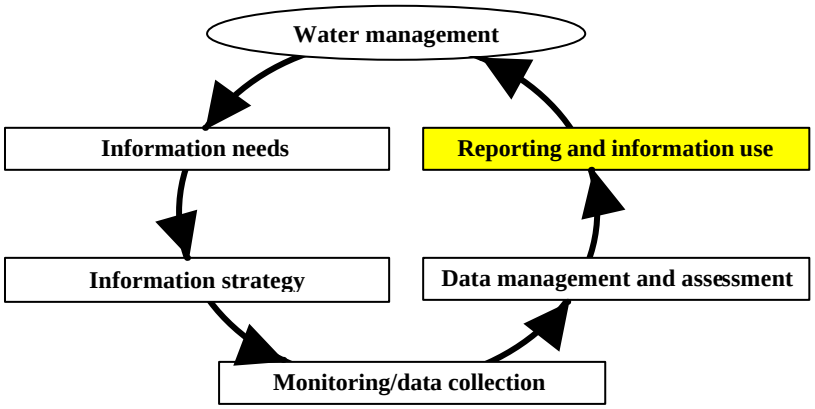
Especially different types of trend calculations are being used for assessing monitoring data. While interpreting trends in water quality, particular attention should be paid to water-quantity data, since hydrology strongly affects water quality.

The use of water classification systems is very common to assess watercourses. Some of them are based on physico-chemical variables, but also biological material is used, like in the ecological classification under the Water Framework Directive.

CHAPTER 8: REPORTING AND USING INFORMATION

Reporting and the use of information for various other purposes is another essential step in the "monitoring and assessment cycle". Processed data and information have also a key role in the further development of the monitoring and assessment programmes to produce the most relevant data.

Environmental information is public according to the EU Directive on public access to environmental information (2003/4/EC) [43] and the Aarhus Convention[28], and it has an especially important role in increasing public awareness of water problems and public participation in water management.



8.1 Reporting

Reports should be prepared on a regular basis. The main issue is to present the interpreted data in an easily accessible and understandable way, tailor-made to the audience addressed.

8.1.1 Reporting obligations

An inventory should be made on national and international reporting obligations to be able to fulfill reporting requirements laid down in water management legislation and applicable transboundary agreements and EU Directives as well as relevant decisions taken at international forums (see chapter 2). The Reporting Obligations Database (ROD)[44], developed by the European Environment Agency (EEA), includes an overview of many international reporting obligations.

[43] europa.eu.int/eur-lex/pri/en/ oj/dat/2003/l_041/l_04120030214en00260032.pdf
[28] www.unece.org/env/pp/documents/cep43e.pdf
[44] http://rod.eionet.eu.int/text.jsv?mode=D

8.1.2 Reporting formats and audiences

The level of detail included in the reports and the frequency of compilation also depend on the recipient. The content of the report should be targeted to the needs of the recipient, which includes international bodies, management and scientific institutions, national administrations and the public. Depending on the needs of target group, the report contains aggregated information (e.g. indexes, quality indices) and/or detailed information in tables, statistically processed data, graphs, and geographically presented information.

Public authorities, including joint bodies, usually request information in a specific format and frequency, which are defined in "reporting protocols or reporting schemes". Such reports are usually presented in writing to ensure unambiguous understanding of the results. In addition, public authorities may have ad hoc requests for information, which is not predefined in reporting protocols, but related to specific current topics in water management. This kind of reporting has to meet strict requirements concerning response time and flexibility.

Reporting to ordinary people and their associations, organizations or groups usually follows an ad hoc request for information and can hardly be predefined in reporting protocols. Guidance is provided in the Aarhus Convention[28] and the Guidelines on public participation in water management[41].

A state-of-the-environment report should provide concise information for decision-making in water management. These reports typically provide information on the functions of the water body, describe the existing problems and the pressure they put on the water body, and give insight into the impacts of corrective measures. Their decision-making value strongly increases by visualization tools and the introduction of indicators, in particular if the elements of the DPSIR framework are reported.

The form of a joint report for the purposes of water management in the basin should be agreed upon in detail by the riparian countries. Harmonisation of reporting is strongly encouraged. Joint reporting naturally puts high requirements on data comparability (e.g. standardisation of laboratory analyses). The reports should particularly highlight the links between policy measures and the status of the water body of concern. Periodic assessments under the Water Convention, covering all transboundary water basins in the region, is also recommended (e.g. every three years) to encourage the evaluation of progress made under the Convention, stimulate commitment of the members involved, and make results available to the public.

The Internet provides a powerful tool for sharing and communicating information and can be used to inform and involve the public. Traditionally, authorities have been very cautious in presenting environmental information and data to the public because of the risk of misinterpretation of information by laymen. However, involving the NGOs and the public in transboundary water management promotes awareness raising thus stimulating more sustainable cooperation to develop between countries.

8.2 Information use

The information produced must be used. The monotoring and assessment cycle shown above is only completed properly if the information is conveyed so that it contributes to management decisions. The information products in their various forms of maps and reports outlined in

[28] www.unece.org/env/pp/documents/cep43e.pdf
[41] http://europa.eu.int/comm/environment/water/water-framework/guidance_documents.html

section 8.1 therefore need to be accessible and attractive to the information users, and convey the messages that they really need.

The information product should be based on the information needs as specified and, in particular, the information should be clearly linked to the relevant part of the DPSIR framework. While much of the information derived from a monitoring programme has its most direct association with the status of transboundary waters, interpretation and assessment in relation to the drivers and pressures and how these are changing with time, and in relation to impacts on, for example, health of water users must be included. Further, information products from the assessment specifically related to responses, for example, the effectiveness of measures to protect or restore will be required by water managers. The information product should consequently provide the full range of the DPSIR framework, therewith enabling decision making about future actions and measures. Added to this, the information should create improved awareness of the importance of proper water management and the negative impacts of neglect and inadequate use.

Use of the information should also feed back into the design of monitoring and assessment, and be seen as providing scope for re-entering the assessment cycle. This may lead to revision and improvement of the monitoring programme, review and possibly changes in the information needs and the consequent priorities for monitoring and assessment, including reviewing the most effective use of the available funding. While the assessment and monitoring programme needs stability and continuity to meet information needs and regulatory requirements, the elements of the assessment cycle should not be considered as totally 'fixed'. They may need to be modified and tailored to suit changing drivers and pressures (perhaps new industries and new chemicals) and new legal requirements and obligations. The assessment cycle should, therefore, rather be seen more as a continuously evolving spiral, gradually improving as time goes on.

Increasingly, many of the information users are stakeholders rather than managers, i.e. the users of the water and the ecosystems they support. Information may need to be targeted differently for these groups than for managers through, for instance, the internet, mass media and conferences. Where managers can be reached through reports and meetings, the internet provides a powerful tool for sharing and communicating information and can be used to inform and involve the general public. Traditionally, authorities have been very cautious in presenting environmental information and data to the public because of the risk of misinterpretation of information by lay people. However, involving NGOs and the public in transboundary water management will promote awareness and help to stimulate more sustainable cooperation between riparian countries.